6 ENVIRONMENTAL CONSEQUENCES

INTRODUCTION - FUTURE WITHOUT-PROJECT CONDITIONS (STOCHASTIC FUTURE AND SCENARIO FUTURE)

The future without-project conditions are basically a continuation of the base natural resource conditions along with the local flood damage reduction measures (i.e., infrastructure protection) described earlier in this report and the technical appendices. The major difference between the stochastic and scenario conditions is when and to what degree infrastructure protection measures are implemented and the likelihood of a natural overflow to the Sheyenne River.

The Corps of Engineers has concluded that the public will be best served by implementation of the Pelican Lake 300 cfs outlet plan. The preferred alternative consists of an outlet from Pelican Lake to the Sheyenne River. It would include open channel from Pelican Lake to the pump station located just north of Minnewaukan and a buried pipeline from the pump station to the Sheyenne River. A regulation reservoir would be located at the divide to regulate flows to the Sheyenne River. The outlet operation would be constrained to a 600 cfs channel capacity (maximum outlet flow 300 cfs) and a 300-mg/l-sulfate constraint on the Sheyenne River. Other features of the plan include a sand filter to address biota transfer, erosion protection measures along the Sheyenne River, protection of cultural resource sites along the Sheyenne River, construction of by-pass channels to alleviate effects to aquatic resources, water treatment for municipal and industrial water users, the acquisition of 6,000 acres of riparian lands along the Sheyenne River for mitigation, and the acquisition of flowage easements. Long-term monitoring and adaptive management is also included to evaluate the effectiveness of the mitigation features and to determine the need for additional mitigation measures.

The least environmentally damaging plan would be the continuation of infrastructure protection. Upper basin storage would also cause few impacts to natural resources, would result in benefits to natural resources, but could result in significant adverse social effects to landowners. Impacts to cultural resources, as a result of upper basin storage, are unknown. Further investigation of the feasibility of upper basin storage is warranted. Controls on future drainage should also be implemented as part of an environmentally preferred plan. The Pelican Lake outlet is the least damaging of the outlet alternatives.

The significant resources are identified and defined in Chapters 4 and 5.

STOCHASTIC FUTURE

Table 6-1 is a summary impact matrix. More detailed discussion is presented in the following sections and in the technical appendices. Only significant resources that would be affected are discussed. Resources that are not affected are not addressed. See Appendix C for additional information on natural resources.

Future Without-Project Conditions

The stochastic analysis identifies that there is about a 9.4-percent probability that the lake will overflow in the next 50 years. The environmental analysis based on the stochastic future assumes it is unlikely that the lake will overflow naturally. The future downstream conditions would be determined by forecasting the existing conditions and evaluating the effects of project alternatives.

Figure 6-1 describes the stochastic-based probability of the lake reaching various elevations over the next 50 years.

Table 6-1 – Stochastic Analysis Impact Matrix

Resource Category	Alternative			
	Future Without Condition	Expanded Infrastructure Protection	Upper Basin Storage	Pelican Lake Outlet (Preferred Alternative)
Natural Resources	Fishery in lake will continue to improve to a point. Potential for new species to be introduced due to recreation and creation of new habitat. Eventually, lake will recede and fishery will decline. Continued construction of levees and roads could affect resources. About 500 acres would be affected. Infrastructure protection would have limited effect on probability of natural overflow, lake levels, and resultant effects. Construction activities would have temporary effect on aquatic habitat such as turbidity. Little long-term effect on fishery. No effect downstream because probability of overflow is relatively small. Risk of biota transfer from natural causes and recreational users. Devils Lake and Red River species are similar.	Would have limited effect on probability of natural overflow, lake levels, and resultant effects. Construction activities would have temporary effect on aquatic habitat such as turbidity. Little long-term effect on fishery. About 3,000 acres of lake bay type habitat would be affected by changed hydrology. Previously developed areas may be reclaimed. Little change from Future Without condition.	Upper basin storage would be greatly expanded over current or anticipated levels. Upper basin storage would reduce runoff to lake, resulting in lake levels about 1 foot lower. Some fresher water would be retained in upper basin. Would prevent inundation of some land areas and loss of habitat. About 65% of the sites are in agricultural uses. Would result in loss of agricultural uses and increase in wetland habitats and values. Little effect on probability of natural overflow. Increase in wetland and grassland habitat.	Most of the fresh inflow removed before it enters Devils Lake. Lake reaches lower levels sooner, increase in TDS and sulfate over without-project condition. Upper basin lakes used for storage, subject to increased fluctuation resulting in decreased habitat value. Lake Alice National Wildlife Refuge affected, requiring compatibility statement. Lower lake levels would expose shoreline sooner, resulting in quicker successional recovery of terrestrial habitat. There are 219, and 82 Natural Heritage sites located within 1/4 mile of Sheyenne, and Red Rivers, respectively. Limited effects to heritage sites due to operation constrained by water quality and channel capacity. Changes in water quality could affect aquatic communities. Increased groundwater levels would affect soil salinity, land uses, composition of habitat, and access to and across river. Biota transfer is issue with outlet; possibility of transfer and introduction of new species would increase due to outlet operation. Potential for spread of Eurasian watermilfoil. Sand filter designed to minimize possibility of biota transfer. Aquatic resource recovery facilitated through mitigation features including erosion protection and bypass channels.
Cultural Resources	Excavating borrow material, constructing temporary levees, raising the City of Devils Lake levee, and relocating houses and utilities all have potential to adversely affect cultural resources, as do inundation and wave-caused erosion at Devils Lake and eventually Stump Lakes. No effect on sites along the Sheyenne River because the probability of natural overflow is relatively small.	Same effects as future without, plus additional impacts to cultural resources where earth dams constructed and at borrow areas for same.	Expansion of upper basin storage may result in inundation of cultural resources located at the restored wetlands. Construction of outlet structures may also affect cultural resources sites.	Pelican Lake outlet has yet to be surveyed for cultural resources. Cultural resources sites along the outlet alignment would be affected by construction. Known site at confluence of Peterson Coulee with Sheyenne River needs evaluation of National Register eligibility and may need mitigation excavation prior to construction. Increased quantity and duration of high water in Sheyenne River would cause increased erosion of cultural resources sites along its banks over what occurs naturally. Mitigation of impacts to cultural resources sites along Sheyenne River would be necessary.

Table 6-1 – (Continued)

Resource Category	Alternative			
	Future Without Condition	Expanded Infrastructure Protection	Upper Basin Storage	Pelican Lake Outlet (Preferred Alternative)
Social Resources	Eight of the eleven social effects categories are rated as being substantially or significantly adversely affected under the without-project condition with no overflow. Environmental justice is not affected and aesthetic values have minor adverse effects, while recreation is substantially affected in a positive manner due to the positive relationship between higher lake levels and quality of fishing experience. The impact of the without-project condition on the economic criteria ranges from no effect to significantly adverse. Categories rated as significantly adverse are "Transportation," "Employment, Regional Growth," "Business Activity," and "Fiscal Effects." Public Services would be adversely affected to a substantial degree.	The only significant effect caused by the infrastructure protection plan is in the category of "Public Safety." This is a positive effect resulting from the significant increase in safety for those living in areas protected by the roads-as-levees and for those motorists traveling along the roadways. All other categories are rated as having either no effect or a minor effect.	In general, upper basin storage will have a minor positive effect on most social and economic evaluation categories compared to the without-project condition. An additional element of controversy would be added by implementing a plan that is not acceptable locally or viewed as ineffective in reducing lake levels. An additional negative aspect related to land use would be added as well. Conversion of approximately 40,000 acres of the depressions to storage would preclude continuation of normal agricultural operations on these lands.	Generally, the Pelican Lake outlet is expected to have minor to substantially positive social and economic impacts compared to the without-project condition. Substantial improvements anticipated with the outlet in place would be expected in the areas of "Community Cohesion," "Community Growth," "Controversy," "Employment," "Regional Growth," and "Business Activity." Community cohesion and controversy would be adversely affected between Devils Lake communities and downstream communities. A substantial adverse effect would be anticipated for "Energy Resources" due to the significant amount of energy required to operate the pumps.
Other States, Nations, and Tribal Resources	Natural conditions would prevail. No conflict with Boundary Waters Treaty would be expected. Controversy over boundary with Spirit Lake Tribe may continue. Environmental Justice issues would continue. Damages due to rising lake levels would continue. Downstream effects are not a major issue due to small probability of natural overflow.	Not much change from future without-project conditions. Road raise and levee construction would continue as needed.	Not much change from future without-project conditions. Upper basin storage is preferred by other States and Canada.	Outlet in general is not acceptable to downstream interests. Minnesota and Canada have opposed outlet due to water quality and biota transfer concerns. Sand filter would address, to the extent practical, concerns associated with biota transfer. Compliance with Boundary Waters Treaty is an outstanding issue. Spirit Lake Tribe in past has opposed outlets from west end. Lake may continue to rise in spite of outlet. Compliant with Executive Order on Environmental Justice.

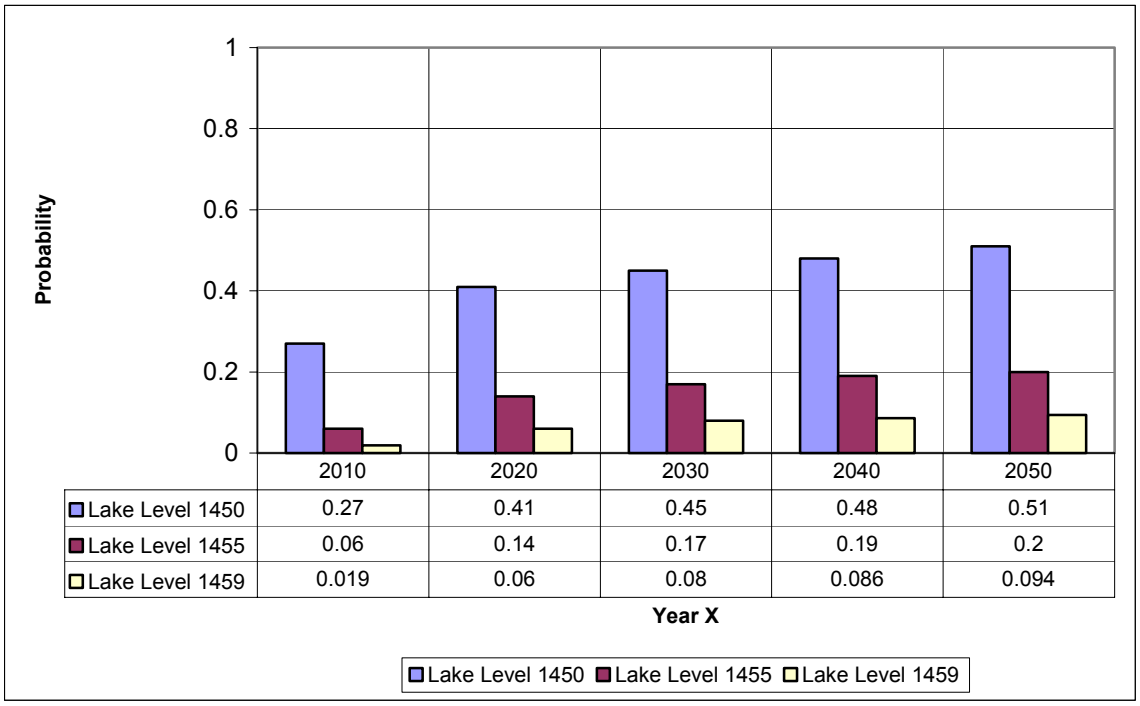

Figure 6-1: Probability of Reaching Lake Level by Year X

Social Resources

Evaluation Criteria

This social impact assessment applies a common set of impact categories to compare the with- and without-project conditions. The criteria were selected on the basis of National Environmental Policy Act (NEPA) requirements for social impact assessments, Corps policy guidance for Environmental Impact Statement (EIS) preparation, and issues identified through the NEPA scoping process. The criteria include the following:

Social Effects	Local Economic Effects
Population Relocation	Environmental Justice – Economic Aspects
Environmental Justice – Social Aspects	Transportation
Public Health	Agriculture
Public Safety	Energy Resources/Use
Noise Levels	Employment
Aesthetic Values	Regional Growth
Recreation	Business Activity
Community Growth/Development	Property Values
Community Cohesion	Fiscal Effects
Land Use	Public Facilities/Services
Controversy	

Social Effects

Population Relocation

Since 1993, there have been 11 Presidential disaster declarations for the Devils Lake region. These declarations were made for regions within North Dakota that extended well beyond the Devils Lake area to address the effects of the climatic wet cycle, including flooding and agricultural impacts. Under emergency authorities, Federal agencies have moved or bought out and abandoned homes that were flooded by the rising lake. Approximately 400 homes around Devils Lake have been moved or abandoned in response to the rising lake waters. While some homes have been abandoned, most homes have been relocated. Some of the houses were second homes, but most were primary domiciles. The Federal Emergency Management Agency (FEMA) led this effort around most of the lake, but the Department of Housing and Urban Development (HUD) has taken responsibility for relocating many structures on the Fort Totten Indian Reservation. FEMA administers the National Flood Insurance Program (NFIP) through which the Federal Government provides flood insurance for those communities that adopt floodplain management ordinances.

At the inception of the program, NFIP procedures were established for riverine flooding. These procedures, which were applied to Devils Lake structures during the initial years of flooding, required that homeowners wait 90 days after inundation to submit an NFIP claim. Claim payments were used to either move the house or buy the house and abandon it. In response to the peculiarities of Devils Lake flooding, FEMA provided a waiver for these procedures for such closed-basin lakes, allowing claims to be processed prior to flooding for those policyholders who signed up before November 1999. This

waiver is contingent on local governments' endorsement of NFIP criteria, including establishing conservation easements on flooded property. In the event that a falling lake exposed previously inundated properties, these easements would allow farming or temporary homes (e.g., trailers), but no permanent structures. There has been mixed reception by lakeside communities to the waiver/endorsement offer from FEMA. The economic costs of potential relocations induced by an additional rise of Devils Lake have been accounted for in the National Economic Development (NED) analysis. On the basis of past experience in Devils Lake, the cost of moving a home is approximately 70 percent of market value, not including the new lot.

This relocation of over 400 homes has had significant short-term and long-term impacts on communities and individuals involved. It is likely that the physical conditions on the lake under the with- and without-project conditions would require additional relocations of homes and commercial structures with consequent social and local economic disruption.

The following discussions explore the social and local economic effects of population relocation. The short-term and long-term social impacts of additional lake rise are described first with subsequent exploration of potential population relocations associated with the alternative plans.

Short-Term Effects of Lakeside Population Displacement - Past experience with the rising lake provides a model for understanding the social and local economic impacts of population relocations. The short-term social and local economic impacts of the rise of Devils Lake are summarized below.

Dislocation of People's Lives: For many lakeside residents that have been forced to relocate due to rising lake levels, the dislocation has had significant adverse effects on their lives. The impacts have been diverse, depending on whether one's home was moved or abandoned and whether it was a primary or second home. The ability of the residents to cope with the change is determined by a variety of factors, including personality, age, income, ethnicity, family support, and community support. Although most of the monetary burdens of relocation were borne by Federal emergency funds, the social disruption caused by the relocations was severe for those involved. For relocated families, disruption included loss of neighbors, loss of community, economic losses not covered by Federal funds, and uncertainty about where to move. Those who were not directly involved were still affected, since many lakeside communities were fractured by the loss of neighbors.

Living With Uncertainty: On the basis of interviews with mental health professionals at the Lake Region Human Service Center (LRHSC) in the City of Devils Lake, the uncertainty associated with the rising lake took a significant toll on individuals and on the lakeside community. The LRHSC is one of eight regional, multi-functional centers maintained by the North Dakota Department of Human Services. The slow, relentless creeping level of the lake over many years has caused significant anxiety for many

lakeside residents. There is significant anticipatory stress regarding if and when the lake would rise to threaten one's home.

Crisis counseling is a standard element of a suite of post-disaster responses supported by FEMA through emergency grants to community health centers, such as LRHSC. Devils Lake represents a paradigm shift for crisis counseling, since the crisis of the rising lake has been characterized by an almost continuous incident period. For some whose properties are threatened by the rising lake, it has created a siege mentality. These people struggle to maintain normal lives, but they can experience considerable anticipatory stress about moving or losing their homes. One of the most stressful aspects of the rising lake has been the inability to control it. The inability to control one's future magnifies the stress of adversity.

According to the mental health professionals at LRHSC, many residents of the Devils Lake region pride themselves on being self-reliant and stoic in the face of adversity. In addition, the community over time has adjusted somewhat to the social effects of retreating from the advancing lake as the number of families dislocated has grown. These factors have increased community resilience, which has helped those dislocated and threatened by the rising lake cope with the anticipatory stress. However, the crisis of the rising lake has accompanied a multi-year downturn in farm economics, consisting of falling commodity prices, rising costs of farm inputs, and decreased productivity due to the continuing wet climatic cycle. Coupled with ongoing stressors such as lake level rise and the agricultural downturn, the impact of a trigger event, such as a death in the family, can prompt extreme emotional distress in even the strongest individuals.

The LRHSC mental health professionals characterize the farm crisis and the lake crisis as weighing heavily on the communities surrounding the lake. These stressors fall mostly on communities that are lacking in mental health services. For those Native Americans living on the Fort Totten Indian Reservation, these problems are accompanied by a complex set of social and economic problems associated with reservation life.

The LRHSC professionals indicate that the additional stress on lakeside communities associated with the rising lake is difficult to isolate or quantify. They characterize this stress as supplementing a set of stressors that are already in place. Domestic violence, which is one indicator of community stress, has not increased in recent years. However, suicide continues to plague young people in the region, particularly Native Americans. The 1999 publication *Suicide in North Dakota* identifies suicide as the second leading cause of death for North Dakota children in the 10- to 14-year age group, the 15- to 19-year age group, and the 20- to 24-year age group. The national average suicide rate for children aged 10 to 14 years is 1.6 per thousand. The North Dakota average is 6.1 per thousand. North Dakota is ranked second among States for completed suicides of children 10 to 14 years and sixth for young people 15 to 19 years. The Fort Totten Indian Reservation has a suicide rate approximately 3.5 times greater than any other geographical area in North Dakota.

Impacts on Local Community: The impacts and anticipation of impacts on individuals have permeated communities surrounding Devils Lake. One community, the Town of Churchs Ferry (northwest of the City of Devils Lake), was entirely bought out by FEMA and abandoned in 2001. According to Ramsey County officials, some of the residents moved into the City of Devils Lake; others moved into other small towns in the area; and some residents left the Devils Lake area. The entire City of Minnewaukan (2000 population: 318) is at risk from the rising lake. In 1993, the city was 8 miles from the lakeshore. Currently, the lake is inundating parts of the city and threatening the entire community. In the case of Minnewaukan, the anticipatory stress experienced by individual homeowners is felt by the entire community. This relatively poor community has had to make difficult decisions about whether and how to protect city infrastructure from the rising waters. Full protection to 1459 feet above mean sea level (msl) is not economically feasible. Consequently, the city must temper every decision with the uncertainty about whether or not the lake will go higher. A temporary levee has been proposed for the city with an anticipated level of protection to 1454 feet msl. A potential buyout offer from FEMA may weaken the resolve of some residents and divide the community regarding the best course of action under the challenging circumstances.

Long-Term Effects of Lakeside Population Displacement - The long-term effects of relocations may be a significant reduction in quality of life for those who were forced to move. Whether their property was a primary or second home, the amenities at the new location may not equal those at the lakeside location. As in the case of Churchs Ferry, some residents that were forced to move may permanently leave the Devils Lake area. This social change could have economic implications as it weakens the structure and vitality of the community and the local economy. Economic implications could include reductions in: (1) business activity, (2) the local tax base, and (3) the likelihood of business to make new investments in the Devils Lake area.

Lake Level Changes - It is possible that several of the physical changes that are expected to accompany the alternative future conditions would induce additional population relocation. As discussed below, if the lake continues to rise under with- or without-project conditions, significant relocations may be required.

As estimated, using average household size data from the 2000 Census, there are approximately 2,994 people living in the potentially inundated area by lake level rise (i.e., from the current level of 1448 msl to the 1459 msl overflow elevation). Most of this area is farmland, but there are many homes and other structures at risk. There are approximately 1,211 residential structures and 143 commercial and industrial structures between elevation 1445 msl and 1459 msl. Ramsey County contains more than 90 percent of the residential and commercial/industrial structures potentially affected by the rising lake. Those structures inside the levee of the City of Devils Lake are not considered at risk, since the without-project condition assumes that the levee system would be raised as needed to protect the city in the event of additional lake rise. There are 917 residential structures protected by the levee and 188 residential structures unprotected. Not all of the protected structures are located within the city limits. The vast majority of commercial/industrial structures at risk are inside the levee and within the city limits.

Environmental Justice – Social Criteria

Background: Potential population relocations associated with the alternative plans raise the issue of who would be impacted by the alternatives and the equity of those impacts. In 1994, President Clinton signed Executive Order 12898 to address environmental justice in minority populations and low-income populations. This order focuses Federal attention on environmental and health conditions in minority and low-income communities to ensure that all programs or activities receiving Federal financial assistance that affect human health or the environment do not directly or indirectly discriminate on the basis of race, color, or national origin.

As directed by the Executive Order, the goal of an environmental justice analysis is to determine whether minority or low-income communities would bear a disproportionate burden (economically, environmentally, or culturally) from implementation of the alternative plans. Assessment of the environmental justice of the alternative plans involves two principal criteria: minority populations and low-income populations.

In 2000, the Environmental Justice Program of the Environmental Protection Agency (EPA) prepared *Social Impacts of the Proposed Emergency Outlet to Control Flooding at Devils Lake, North Dakota: An Assessment of Environmental Justice.* The EPA examined the demographics of the Devils Lake study area, considered the potential for disproportionate impacts of an outlet from Devils Lake, stakeholder involvement, and potential benefits and burdens of an outlet. The goal of the study was to determine whether low-income communities or Tribes would have a disproportionate burden or benefit (economically, environmentally, or culturally). There is only one Federally recognized Tribe in the Devils Lake region: the Spirit Lake Sioux. Low-income communities are primarily located in Benson County, south and southwest of Devils Lake, but there are some low-income communities along the upper Sheyenne River.

As part of its environmental justice analysis, the EPA sampled 45 respondents from around the study area that were selected as representative of the various interest groups and populations potentially affected by an outlet. The EPA environmental justice analysis provides insight into the perceptions of interest groups in the Devils Lake study area. This investigation supplements the EPA's environmental justice analysis with detailed evaluation of populations and communities potentially affected by the alternative plans to address flooding at Devils Lake. The environmental justice analysis is presented in separate sections devoted to social aspects of environmental justice (i.e., potential effects on minority populations) and economic aspects of environmental justice (i.e., potential effects on low-income populations).

Minority Populations: The population composition of study area counties is profiled in Table 6-2. The profile includes total population, age characteristics (e.g., population under age 18 and population over age 65), and ethnicity (e.g., white, black, Native American, and other). The county-level profile in this table can be used to identify areas of potential environmental justice concern. Benson County, which contains the Fort Totten Indian Reservation, is an area that merits particular scrutiny. As indicated in

Table 6-2, this county has a Native American population that accounts for 48 percent of the total county population, and the county has a high percentage (36 percent) of population under the age of 18 (likely due to high reservation birth rates). The proximity of the reservation to the lake and potential overflow and outlet routes warrants detailed consideration of the potential environmental justice implications of the alternative plans.

Fort Totten Reservation: The reservation of the Spirit Lake Nation Sioux Tribe (formerly the Devils Lake Sioux Tribe) is located between Devils Lake on the north and the Sheyenne River on the south. The Spirit Lake Sioux belong to the Sisseton-Wahpeton Sioux Band. The reservation was established in 1867 by treaty between the United States and the Sisseton-Wahpeton Sioux Bands.

According to the 2000 Census, the total population on the reservation is 4,435 persons, which represents a population increase of 24 percent over the 1990 population of 3,574. Tribal trust acreage of the reservation is 53,239 acres, or 83.19 square miles. Residents are scattered throughout the reservation with concentrations in the communities of Fort Totten, St. Michael, Crow Hill, and Tokio/Wood Lake. Three small, incorporated towns, Warwick, Hamar, and Oberon, are also located within the reservation boundaries and have primarily Native American populations.

Based on the 2000 Census information, the median age of the reservation resident population is approximately 22.8 years. This is 13.4 years younger than the North Dakota State median age of 36.2 and 12.5 years younger than the United States median age of 35.3. The average household size on the reservation is 3.53, compared to 2.41 for North Dakota State and 2.59 for the United States.

Agriculture constitutes a major economic force for the tribe with much of it through the leasing of lands to outside interests. Both tribal and federal governments are a major source of employment, and the tribe maintains a 40-acre industrial park and owns two manufacturing enterprises that employ approximately 300 people. There is a gaming casino on the reservation. Other attractions include the Fort Totten historical site, Sullys Hill National Game Preserve, and an archeological site.

The four major reservation communities contain tribal low-rent housing units, HUD homes, and mutual self-help homes. In 1988, 45 HUD housing units were constructed. Rural farmsteads consist of privately owned homes. Government quarters are maintained almost exclusively by the Bureau of Indian Affairs (BIA).

Although the North Dakota Game and Fish Department routinely conducts angler surveys on Devils Lake, the Department does not survey anglers along the Reservation shoreline of the lake due to jurisdictional considerations. Consequently, there is no information available regarding subsistence fishing by Reservation inhabitants on Devils Lake. However, due to the proximity of the lake, it is likely that the lake serves as an important food source for some reservation inhabitants.

Lake Level Changes: Further rise of Devils Lake would impact Ramsey, Benson, and Nelson Counties. Ramsey and Nelson Counties do not contain large concentrations of minority populations. The lakeside location of the Fort Totten Indian Reservation in Benson County could imply that Native Americans could be disproportionately impacted by further lake rise. Table 6-3 profiles the population composition of areas subject to inundation if the lake rises from its current elevation (1448 feet msl) to its overflow elevation (1460 feet msl). This table is based on block-group data from the 2000 Census. As suggested by Table 6-3, Native Americans would potentially comprise a large percentage (29 percent) of the population at risk from further lake rise. However, the block groups are difficult to align with the area potentially inundated and their boundaries significantly exceed the limits of inundation. In addition, discussion with tribal representatives indicates that all structures below 1460 feet msl have been relocated to higher ground, and further lake rise should not result in significant structural damage to properties in the reservation. No significant impacts to Native American subsistence fishing on Devils Lake would be anticipated with lake level fluctuations.

Public Health

The mental health effects of the rising lake levels were discussed previously in the context of homeowners anticipating the need to relocate to higher ground. As evidenced during the lake rise of recent years, there are other notable health effects of the rising lake, including the following:

***Chronic Wet Basements*:** The wet climatic cycle has raised water tables around the Devils Lake region. This has led to wet basements and problems with mold and mildew. There have been reports around the region of individuals with consequent respiratory problems. Areas around the lake are particularly exposed to these problems due to the high water table and humid atmospheric conditions.

***Access to Health Care and Emergency Services*:** The City of Devils Lake serves as the principal health care center for the lake region. Facilities include Mercy Hospital, the Lake Region Nursing Home, and the Lake Region Clinic. Mercy Hospital is a 50-bed facility that serves Ramsey, Benson, Nelson, and Eddy Counties. It includes primary care, acute care, laboratory services, surgery, a 24-hour emergency room, and outpatient services. The hospital has 157 full-time and 85 part-time employees. The Lake Region Nursing Home has 150 full-time and part-time employees. The Lake Region Clinic is a family practice and internal medicine facility with general surgery and a laboratory. The clinic has 13 physicians and 55 full-time and 30 part-time employees.

As discussed previously, the rising lake has induced extensive road raising around the lake. Many lakeside roads have been closed temporarily during the construction periods. This has significantly decreased access of some communities (e.g., Minnewaukan) to emergency and non-emergency health care. Longer travel times to health care facilities have created significant inconvenience and anxiety in affected communities, especially for their senior citizens who have greater health care needs and greater difficulty with travel.

Table 6-2
2000 County Population Composition Devils Lake Study Area

Impact Zone	County	Total Population	Under 18	% of total	65 years & over	% of total	White	% of total	Black or African American	% of total	American Indian	% of total	Asian, Other, or Combination	% of total
Upper Basin	Cavalier	4,831	1,188	25%	1,107	23%	4,739	98%	7	0.1%	25	0.5%	60	1.2%
	Towner	2,876	708	25%	670	23%	2,799	97%	2	0.1%	59	2.1%	16	0.6%
	Subtotal	7,707	1,896	25%	1,777	23%	7,538	98%	9	0.1%	84	1.1%	76	1.0%
Lake Area	Benson	6,964	2,513	36%	941	14%	3,541	51%	7	0.1%	3,346	48.0%	70	1.0%
	Ramsey	12,066	3,019	25%	2,266	19%	11,138	92%	25	0.2%	651	5.4%	252	2.1%
	Nelson	3,715	820	22%	1,019	27%	3,662	99%	3	0.1%	13	0.3%	37	1.0%
	Subtotal	22,745	6,352	28%	4,226	19%	18,341	81%	35	0.2%	4,010	17.6%	359	1.6%
Downstream, ND	Eddy	2,757	651	24%	682	25%	2,657	96%	2	0.1%	65	2.4%	33	1.2%
	Griggs	2,754	621	23%	708	26%	2,735	99%	0	0.0%	6	0.2%	13	0.5%
	Steele	2,258	624	28%	442	20%	2,220	98%	1	0.0%	14	0.6%	23	1.0%
	Barnes	11,775	2,624	22%	2,332	20%	11,529	98%	53	0.5%	90	0.8%	103	0.9%
	Ransom	5,890	1,471	25%	1,250	21%	5,768	98%	11	0.2%	19	0.3%	92	1.6%
	Richland	17,998	4,437	25%	2,746	15%	17,428	97%	62	0.3%	299	1.7%	209	1.2%
	Cass	123,138	28,848	23%	11,901	10%	117,106	95%	996	0.8%	1,325	1.1%	3,711	3.0%
	Traill	8,477	2,104	25%	1,623	19%	8,249	97%	9	0.1%	80	0.9%	139	1.6%
	Grand Forks	66,109	15,735	24%	6,368	10%	61,479	93%	904	1.4%	1,525	2.3%	2,201	3.3%
	Walsh	12,389	3,091	25%	2,390	19%	11,752	95%	41	0.3%	126	1.0%	470	3.8%
	Pembina	8,585	2,140	25%	1,674	19%	8,198	95%	13	0.2%	123	1.4%	251	2.9%
	Subtotal	262,130	62,346	24%	32,116	12%	249,121	95%	2,092	0.8%	3,672	1.4%	7,245	2.8%
Downstream, MN	Clay	51,229	12,822	25%	6,597	13%	48,149	94%	268	0.5%	740	1.4%	2,072	4.0%
	Norman	7,442	1,915	26%	1,558	21%	7,092	95%	8	0.1%	129	1.7%	213	2.9%
	Polk	31,369	8,128	26%	5,463	17%	29,543	94%	104	0.3%	408	1.3%	1,314	4.2%
	Marshall	10,155	2,583	25%	1,881	19%	9,873	97%	10	0.1%	29	0.3%	243	2.4%
	Kittson	5,285	1,325	25%	1,141	22%	5,184	98%	8	0.2%	14	0.3%	79	1.5%
	Subtotal	105,480	26,773	25%	16,640	16%	99,841	95%	398	0.4%	1,320	1.3%	3,921	3.7%
	Total	398,062	97,367	24%	54,759	14%	374,841	94%	2,534	0.6%	9,086	2.3%	11,601	2.9%

Source: U.S. Bureau of the Census.

Table 6-3
Population Profile of Census Block Groups Along Outlet/Overflow Routes
2000

2000 Census Block Level Data	Total population	Under 18	% of total	White	% of total	Black or African American	% of total	American Indian	% of total	Asian, Other, or Combination Asian	% of total
Further Lake Level Rise*	11,745	3,774	32%	8,211	70%	8	0.1%	3,405	29.0%	121	1.0%
Overflow: Tolna Coulee	688	156	23%	683	99%	-	0.0%	1	0.1%	4	0.6%
Pelican Lake Outlet	1,828	455	25%	1,736	95%	3	0.2%	66	3.6%	23	1.3%

* Assumes continued levee protection of City of Devils Lake
Source: U.S. Bureau of the Census.

The prospect of rising lake levels affecting the regional health care service of the City of Devils Lake is uncertain due to the dilemma posed by the roads serving as dams and the challenges of constructing additional road raises. However, access to health care is one of the most compelling arguments for maintaining transportation access around the lake.

***Effects on School-Age Children*:** These transportation problems have similarly affected some school children that are bused around the lake to schools in the City of Devils Lake. When there has been lake-induced road construction during the school year, the commutes of some children have been dramatically increased. Parents and school administrators have expressed concern that this may cause undue stress on this vulnerable group.

***Sewer Systems and Septic Tanks*:** The rising lake has homes served by centralized wastewater treatment facilities and by septic tanks. Of the approximately 400 residential properties inundated by the lake, approximately 250 have been served by centralized wastewater treatment facilities, primarily Ramsey County Rural Utilities and the City of Minnewaukan. The remainder use individual septic systems. Health effects have been minimized by anticipation of the inundation. Centralized systems have been modified in response to the rising lake, and septic systems on flooding properties were emptied prior to inundation. Any wastewater leakage during these activities was diluted in the lake. Further lake rise would present the same infrastructure issues, but the health effects are anticipated to be minor.

Public Safety

There are two primary safety effects of the further rise of Devils Lake. First, as the lake inundates more land, floating debris is released. This debris is hazardous to Devils Lake

boaters. Second, as the lake continues to rise, more roads around the lake will be affected. A greater length of roadways will have smaller shoulders along raised embankments with steep walls dropping into the lake. If the lake goes up, there is additional pressure on the roads serving as levees, and motorists and those protected by the road-as-levee may be at risk. Additional road construction may re-create safety hazards associated with recent road raising, including dusty driving conditions with low visibility, high volumes of construction vehicles, and wave overwash of roadways with consequent low visibility, icy conditions, and debris problems. These roadways may be particularly dangerous during winter weather conditions when visibility is severely restricted. The lake could also threaten freight and passenger rail lines on the north side of the lake. However, Burlington Northern and Amtrak have committed to a track raise, which should significantly reduce safety risks and potential economic effects for the rail industry and rail shippers.

There is another issue that concerns the behavioral response of populations at risk in the City of Devils Lake to the potential for the city's levee to fail. The potential for tornadoes and other severe weather, such as the macroburst in 2000, has accustomed residents of the city to seek shelter in response to emergency sirens. A warning siren for an impending levee failure could induce the same behavior. Rather than seek high ground, residents could inappropriately respond by seeking the nearest shelter. Ramsey County is currently revising its emergency action plan. The plan will include different siren patterns to direct people how to respond to different threats, including severe weather and a levee break.

Noise Effects

The only significant noise effects anticipated to accompany further lake level rise are those associated with construction activities to raise levees and roads as part of the without-project conditions. This construction activity could generate significant amounts of noise at the construction site and along roadways used as an access route for construction equipment and materials. There may be some noise effects associated with house relocations in response to a rising lake, but these effects would be minor.

Aesthetic Values

Further rise of the lake may have positive and negative impacts on aesthetic values around the lake. Negative effects may include blockage of lake vistas for some lakeside residents due to levee construction or raised roads. Positive effects may include new or expanded lake vistas for not-at-risk residents around the lake. While the aesthetics of an expanded lake occupied by dead or dying trees may depend on the beholder, the aesthetics of mud-encrusted land exposed by receding waters in the distant future may be less subjective.

Recreation

As discussed in the above profile of existing conditions at Devils Lake, recreation at Devils Lake has thrived as the lake has risen. Based on the results of the stochastic analysis of lake levels and the wet scenario evaluation of peak and 50th year lake levels, the lake level is expected to remain well above its historic average. Given the improvement in the quality and quantity of fishing in recent years, there is a positive relationship between lake levels and lake recreation. However, the rising lake has also inhibited recreation due to difficulties in accessing the lake and the cost of modifying recreation facilities in response to the lake's rise.

Community Growth/Development

The emphasis in this category is on social development, specifically whether or not the community is vibrant and poised for growth. The economic prospects of local communities are discussed with the local economic effects. The future conditions could affect community growth and development by affecting (1) the existence of the community, (2) the physical area needed for continued expansion, and (3) actual risks and perceived risks that threaten the community.

The case of Churchs Ferry, discussed previously, provides an example of a community that ceased to exist as a result of the rising lake. This small community was being threatened by the rising waters of Devils Lake, which were backing up Mauvais Coulee (which surrounded the town). In 1999, FEMA proposed to buy out the residents of Churchs Ferry at a total cost of $3.5 million. In 2000, 52 of the 56 homes in the community were purchased by FEMA, and 33 homes were demolished and 19 homes were moved. Of the six commercial structures in the community, four were razed, and two were moved. The BTR elevator and a church have not been bought out at this time.

The existence of the City of Minnewaukan is similarly threatened with inundation by further rise of Devils Lake. If the lake level reaches 1451 feet msl, much of the city will be inundated. As the lake has risen, area available for economic development of the community has been reduced. In addition, the threat of inundation hangs over the community, reducing the prospects for growth and development. Retention of young people in the community, creation of jobs, and attraction of new investments to this already shrinking community are further challenged by the threat of additional lake level rise.

The City of Devils Lake experiences similar challenges derived from the threat of the rising waters. The perceived risk may be more damaging to community vitality than the actual risk. Although it is unlikely that the City of Devils Lake would be inundated, there is a perception propagated by media coverage of the rising lake that the city proper is at risk. According to economic development officials, multiple enterprises have postponed or deferred decisions on new investments in the city. This stigma reduces the vitality of the community and its ability to reverse the trend of population loss, through perceived economic stagnation in addition to problems associated with the lake.

Community Cohesion

Communities are groups of people bound together by something held in common - family, culture, ethnic origin, age, gender, religion, political beliefs, or locality. "Community cohesion" is a concept that is difficult to grasp, much less to measure, and it can hold different meanings for different people. For the purposes of this assessment, however, "community cohesion" refers to people's sense of belonging to, and participation within, their local community and how the with- and without-project conditions evaluated herein may affect these factors.

The cohesion of a community can be an important determinant of its ability to respond to adversity. Community cohesion is affected by controversy, which is often engendered by large-scale problems such as flooding and by attitudes towards proposed solutions to those problems. Community cohesion can depend on the scale of the community considered. For instance, people that live in the Devils Lake area and those that live downstream along the Sheyenne River are bound by State and national citizenship. They may also be bound by a common concern about problems associated with Devils Lake levels. However, their sense of community cohesion may be adversely affected when certain solutions to Devils Lake problems are proposed. "Upstream" and "downstream" groups may coalesce around their perceptions of the problem and their support of or opposition to certain solutions. Even around the lake, there are different communities, divided geographically and ethnically, each with their own perspective. For instance, Native Americans on the Fort Totten Indian Reservation may differ with residents of the City of Devils Lake regarding the appropriate solutions to the Devils Lake flooding problem.

There appears to be a general consensus within the communities around the lake that an outlet is needed to control lake levels. This consensus is reflected in State of North Dakota support for an outlet. However, some Native Americans on the Fort Totten Indian Reservation do not share this perspective, maintaining that the lake should be allowed to fluctuate naturally. As a result, there is a lack of cohesion about the best solution to problems of Devils Lake flooding.

Some communities around the lake have also struggled with decisions regarding FEMA buyouts. Buyouts provide the benefits of flood risk reduction to individual homeowners and businesses, but can seriously disrupt or, as in the case of Churchs Ferry, result in the destruction of a community. Individual decisions are complicated by risk perception of the rising lake, perceived fairness of the buyout price, and community responses to buyout proposals. According to some Minnewaukan residents, there has been some community dissent regarding the best solutions for the city. Those favoring buyouts are viewed as surrendering by those who wish to stay and fight for structural solutions to the rising lake levels. The lack of consensus on this issue complicates individual and group decision-making about many issues, and can lead to rifts within communities and among community members.

Land Use/Long-Term Productivity

Future conditions can affect land use in the study area by changing the physical, social, or economic suitability of land for a particular purpose. The Principles and Guidelines define the long-term productivity effects as the maintenance and enhancement of the productivity of resources, such as agricultural land, for use by future generations. It is anticipated that the most significant land use changes would occur around Devils Lake in response to lake level fluctuations.

The two most prominent changes include the inundation of lakeside property and land use controls associated with FEMA floodplain management requirements as part of the NFIP. Since the lake began to rise in 1993, the area of the lake has expanded from 70 to over 200 square miles. This, of course, has affected the area inundated, but it has also affected other lands through secondary effects, including destinations for relocating populations and lands perceived at risk from future lake rises. If Devils Lake continues to rise to its overflow elevation of 1459 msl, the area of the lake would expand to 278,000 acres, or 434 square miles.

Regarding FEMA's impacts on land use around the lake, the agency urged Ramsey and Benson Counties and the City of Devils Lake to adopt permanent land use ordinances establishing conservation easements that prohibit new construction below 1460 feet msl in exchange for the NFIP waiver allowing structures to be moved before inundation. After much deliberation, Ramsey County decided not to adopt the ordinance, but Benson County and the City of Devils Lake decided to implement the ordinance with minor adjustments. There are an estimated 45 people in Benson County who qualify for the flood insurance endorsement and waiver.

Some local protective measures around the lake have entailed small land use changes. For instance, the levees to protect the City of Devils Lake have converted the land use, but the footprints of the levees and associated access roads do not occupy a significant amount of land.

Controversy

As stated previously, controversy and community cohesion are closely tied. Controversy in a community indicates the lack of agreement about a certain issue or problem and an emotional intensity that can create long-lasting fractures in a community's social and economic viability and its ability to respond to adversity. The divisive issues surrounding the problems of a rising Devils Lake and potential solutions were discussed above as affecting the cohesion of communities around the lake and communities downstream along the Sheyenne River. The emotional content that converts disagreements into controversy has been supplied by the speed of the lake's recent rise, the uncertainty of the future behavior of the lake, and the pace of decision-making to address problems of the rising lake. Any course of action to address the rising lake would involve trade-offs between communities within the lake region and between the diverse stakeholders within those communities. In the context of the controversy, the trade-offs are perceived by

many as creating winners and losers. The geographical separation of some of these communities (e.g., lakeside and downstream communities) fuels and facilitates the controversy by allowing the groups of communities to distinguish themselves as "us" or "them." This often results in "not in my backyard" (NIMBY) responses where people recognize the need for action, but actively resist solutions they perceive as negatively affecting them.

Underlying much of the controversy is the uncertainty of the science of climate prediction and hydrologic modeling. There can be no definitive answers to questions regarding how high the lake will go, the likelihood of an overflow, or the water quality effects of an outlet.

One of the purposes of the NEPA process is to fully disclose the potential features and effects of alternatives and to provide a process and forum for full expression (and, it is hoped, resolution) of divergent viewpoints. As such, the project public involvement and scoping processes required by NEPA frequently provide the best expression of the level and extent of public controversy.

Ultimately, it must be recognized that the problems and potential solutions at Devils Lake are highly controversial, and are likely to remain so. Although the Corps' utilization of the NEPA process is unlikely to dispel these controversies, it will identify the controversies so that decision-makers at the Federal, State, and local levels can be fully informed of public perceptions and attitudes.

Communities around the lake have experienced significant adversity during recent years due to the rapid rise of the lake. Each additional increment of rise produces new calls from these communities to solve the problem, with a current chorus of support for an outlet. The State of North Dakota has responded to the prospect of continuation of the wet cycle and additional rise of the lake by pursuing a temporary outlet from the West Bay through Peterson Coulee. For residents of lakeside communities, development of an outlet is perceived as long overdue, and their frustration grows with any additional delays.

Local Economic Implications of Physical Effects

The local economic issues that could arise from the physical effects of the without-project condition are examined below. As will be evident, the regional economy surrounding Devils Lake – like the regional social structure – is an interconnected web of economic activity. The economic evaluation criteria are used to identify the pieces of the puzzle and to assess their linkages.

In the economic analysis conducted as part of the Devils Lake planning process, the economic effects of the alternative plans have been evaluated from the perspective of the National Economic Development (NED) account. Increases in NED that are associated with an alternative represent increases in the net national output of goods and services

resulting from that plan; decreases in NED represent the economic costs of the plan. The principal categories of positive and negative NED effects of the alternatives include:

- Changes in expected flood damages around the lake and downstream along the Sheyenne River and the Red River.
- Changes in costs of flood damage reduction measures (e.g., levees or relocations).
- Changes in the costs of transportation and other infrastructure improvements.
- Changes in water treatment costs for downstream communities.

The NED analysis does not provide a comprehensive assessment of all of the economic effects of the alternative plans. NED analysis is not intended to do so. As suggested by its name, the NED account is intended to support Federal investment decision-making for water resource projects. Therefore, NED analysis takes a national perspective and is more concerned with changes in the total quantity of economic effects (i.e., what are the net costs and net benefits of an action), than with the regional or local distribution of those effects (i.e., who gains and who loses). The Federal water resources agencies have developed rigorous procedures to estimate the NED costs and benefits of alternative plans irrespective of *"...to whomsoever they may accrue."* (Principles and Guidelines, 1983).

State and local governments must also make decisions regarding the economic effects of the problems and potential solutions for Devils Lake. To these units of government, regional and local economic effects are of equal (if not greater) importance in their decision-making process. As a full partner with the Federal Government in any proposed solution, local units of government (and their citizenry) deserve to have these regional and local economic effects described in an equivalent level of detail.

The Devils Lake EIS provides an opportunity to assess local economic effects that are not captured by the NED analysis. The analysis of local economic effects focuses on changes in income distribution rather than net changes in national income. The alternative plans will have different effects on different locales and different groups in the study area. The local economic analysis attempts to evaluate these diverse effects.

The rising lake has adversely affected many residents around the lake. However, even under the adversity produced by the rising of Devils Lake, some parties have benefited. For example, the influx of Federal emergency funds to relocate threatened homes, protect the City of Devils Lake, raise threatened roads, provide crisis counseling, and maintain local infrastructure has brought over $350 million in Federal funds into the Devils Lake region. This has provided a significant boost to some elements of the local economy, such as those individuals and enterprises involved in road construction or house moving, or those individuals or enterprises that support these activities with services (e.g., lodging, restaurants, etc.). In addition, the improvement in the Devils Lake fishery associated with lake level rises has benefited the local recreation-related industry.

Environmental Justice – Economic Criteria

The previous discussion of environmental justice considered the social aspects of this issue, focusing on the potential for minority populations to be affected by the alternative plans for Devils Lake. This section continues the environmental justice analysis, considering economic aspects of this issue, specifically potential effects of the alternative plans on low-income and minority populations. The intent is to determine whether low-income populations in the study area would bear a disproportionate burden under the with- or without-project conditions.

Low-Income Populations: Table 6-4 presents 1997 median household income for the counties in the Devils Lake study area and the percentage of county population with incomes below the poverty level. The poverty threshold is dependent on family size. In 2000, the threshold for an average family of four was $17,603. Tract-level income data from the 2000 Census are not yet available. For this reason, county-level income data are used for the environmental justice analysis.

Table 6-4
Populations in Poverty by County
1997
($2001)

Impact Zone	County	Median Household Income - 1997	Population in Poverty - 1997
Upper Basin	Towner	$27,205	14.8%
	Cavalier	$31,223	12.9%
Lake Area	Benson	$21,833	28.7%
	Ramsey	$30,355	14.8%
	Nelson	$25,831	11.1%
Downstream, ND	Eddy	$26,181	13.0%
	Griggs	$28,108	14.4%
	Steele	$32,659	12.9%
	Barnes	$29,588	13.9%
	Ransom	$32,823	9.6%
	Richland	$36,591	11.4%
	Cass	$38,871	9.0%
	Traill	$35,162	10.9%
	Grand Forks	$35,959	11.2%
	Walsh	$29,847	14.5%
	Pembina	$34,875	10.4%
Downstream, MN	Clay	$37,711	12.5%
	Norman	$29,518	13.9%
	Polk	$32,126	14.3%
	Marshall	$30,975	11.6%
	Kittson	$31,221	12.2%
North Dakota		$31,764	12.5%
Minnesota		$41,591	8. 9%
United States		$37,005	13.3%

Source: Economic Census. 1997.

Lake Level Changes: Most of the counties in the study area have incomes and poverty levels that are consistent with North Dakota and U.S. averages. Benson County is an exception, with a median income well below State and national averages and more than 28 percent of the county population living in poverty. Benson County is located on the south and west sides of the lake and is home to the Fort Totten Indian Reservation. Tribal representatives have indicated that all structures below 1460 feet msl have been relocated to higher ground, and further lake rises should not result in significant structural damage to properties on the reservation. Therefore, any further lake level rises would not result in disproportionate economic impacts on low income groups. No significant impacts to Native American subsistence fishing on Devils Lake would be anticipated with lake level fluctuations.

Transportation

Some roads around Devils Lake would be inundated by further lake rise. Some roads would probably be abandoned, such as Grahams Island Road and Woods-Rutten Road. Decisions about other roads would raise the issues of roads serving as levees with some resolution needed. Other issues previously discussed include additional travel time around the lake, potholes created by construction vehicles, dust and other visibility problems, and aesthetic issues. Those transportation effects that could be quantified were included in the NED analysis. Others have been qualitatively discussed in the previous sections devoted to social impacts of the alternative plans.

Rail lines around Devils Lake are not anticipated to be significantly affected by implementation of the alternative plans. Some of the lines are no longer in use, such as the Red River Valley and Western Railroad line from the south to Minnewaukan and the Canadian Pacific Railroad line from the City of Devils Lake west to Harlow. As part of the without project condition, the track along the Burlington Northern line that runs parallel to U.S. Highway 2 is being raised 3 feet to at least 1460 feet msl. Several other rail lines are spur lines whose main function is to provide service to collect grain from local grain elevators and deliver fertilizer, such as the Burlington Northern Railroad line from Churchs Ferry north to Cando. A rising lake could lead to closure of this line, which would necessitate truck transportation of crops and fertilizer. This would have an adverse effect on those farms currently served by these rail lines, with consequent reduction in farm incomes. These effects are accounted for in the NED economic analysis.

As part of the without project condition, the Devils Lake Regional Airport is not considered subject to inundation by further lake rise. The installation of the levee to protect the City of Devils Lake required loss of approximately 150 feet of airport runway. An additional 200 feet of runway was added to the other end. The airport is now protected by the levee and will continue to be protected under assumptions made for the without-project future conditions.

Agriculture

Approximately 166,000 acres would be inundated by the lake's continued rise to its overflow elevation (estimated using elevations 1445 feet msl and 1460 feet msl). The vast majority of this land is agricultural. Most of the land at risk lies in Ramsey County (105,000 acres, or 63 percent), followed by Benson County (31,000 acres, or 19 percent), Towner County (25,000 acres, or 15 percent), and Nelson County (5,000 acres, or 3 percent). Agricultural land that would be inundated by further rise of Devils Lake lies primarily in Ramsey County, with a relatively small area in Benson County and an even smaller area in Nelson County. The NED analysis estimated flood damages from further lake level rise using the average cost per acre for farmland in the respective counties. While this measure captures the economic effects of farmland inundation from the national perspective, it does not reflect local economic impacts. To do this requires a profile of agriculture around the lake and the expected effects on the local economy of taking farmland out of production.

Agriculture in Ramsey, Benson, and Nelson, and Towner Counties is profiled on the basis of information contained in the 1997 Census of Agriculture. The counties have a similar agricultural profile. The average farm sizes (in acres) of the counties are similar: Ramsey 1,254; Benson 1,255; Nelson 1,136; Towner 1,332. The per-acre market value of land and buildings is also similar: Ramsey $391; Benson $320; Nelson $476; and Towner $376. Wheat, barley, and sunflower are the most popular crops by acreage, with wheat dominant (Ramsey 45.9 percent; Benson 49.7 percent; Nelson 36.5; and Towner 58.1 percent). There are also some significant differences in agriculture in the counties. One difference is the number of farms engaged in cattle production. In Benson County, 49.5 percent of farms raise cattle; in Ramsey County 16.2 percent of farms raise cattle; in Nelson County 28.8; and in Towner County 24.5 percent raise cattle. The market value of livestock (and poultry) sold in Benson County ($10.7 million) greatly exceeds that of Ramsey County ($2.7 million), Nelson County ($5.6 million), or Towner County ($2.9 million). This may be one explanation for the higher net cash return on agricultural sales per farm in Benson County ($6,511) than in Ramsey County (-$1,085), Nelson County ($1,027), or Towner County ($4,203).

Time series of data illustrate the depressed state of the agricultural economy in North Dakota. In particular, the 1987, 1992, and 1997 net cash return per farm was $2,636, $28,600, and -$1,085, respectively. This suggests that the majority of farms lost money in 1997. Anecdotal evidence indicates that little, if any, improvement has occurred since 1997. Farming costs (crops and livestock) exceeded returns at a loss rate of $0.87/acre (i.e., $51,085/1,254 acres). The squeeze on farm profitability is the result of steadily increasing costs of farm inputs and an erosion of commodity prices. From 1993 to 2000, national indexed prices received for food grains declined 14 percent, and prices for meat animals declined 6 percent during the same period.

The farm economy in the Devils Lake area is in a depressed condition that results from low commodity prices. In *Regional Economic Effects of Proposed Devils Lake Outlet,* Leistritz et al. (1999) developed 10-year average crop budgets for spring wheat, barley,

and durum in the Devils Lake region. Again, the depressed condition of the North Dakota farm economy was evident. Per-acre operating losses were estimated for the following crops: spring wheat cultivation (-$17.55 per acre); durum (-$17.90 per acre); and sunflowers (-$7.18 per acre). Barley was profitable at $17.90 per acre.

Further rise of Devils Lake would put additional pressure on the regional farm economy by taking more land out of production. Incomes of farmers whose properties are affected would decline, and their patronage of local agriculture-related enterprises for equipment and crop inputs would be reduced. Impacts on farm income were included in the NED analysis. Although the current negative rate of return in Ramsey County would imply that taking cropland out of production via lake inundation would result in a benefit of reduced farm losses, this would not be expected over the 50-year period of analysis. The local economic effects associated with reduced local farm expenditures can be approximated by applying average farm expenditures to the number of acres inundated. The 1992 Devils Lake Reconnaissance Report estimated that lands subject to inundation by the lake between elevations 1450 and 1455 feet msl have the following uses: cropland (40 percent), pasture (35 percent), and other (25 percent). Similarly, flooded land between 1455 and 1460 feet msl was estimated at: cropland (50 percent), pasture (30 percent), and other (20 percent). Using these land use distributions, the lost annual farm expenditures (crop and pasture) associated with a lake level rise to 1460 msl would be approximately $9 million.

Using information obtained from the 1997 Census of Agriculture for Ramsey County and in *Regional Economic Effects of Proposed Devils Lake Outlet*, Leistritz et al. (1999), it is possible to estimate the per-acre rate of return for pasture for beef cattle. With 24,166 acres of pastureland in the county and 6,124 cattle and calves, there are an estimated 3.9 acres per cow/calf. Using the statewide estimate of Leistritz of approximately $42 of profit per cow, this would result in approximately $11 of profit per acre for livestock. Further rise of Devils Lake would be expected to reduce farm income by this amount for each acre of pasture flooded. Similarly, Leistritz also estimated $370 of expenditures per cow, resulting in reduced spending on farm inputs of approximately $95 per acre.

Although falling lake levels could expose land that was previously farmed, it is unlikely that such lands would be productive for many years. The land might be useful for pasture after 5 to 10 years, but it would not be suitable for cultivation for a longer period because of adverse flooding effects on soils, particularly salinity and wave effects.

Energy Resources/Use

Further rise of the lake might require additional road construction that could imply higher fuel consumption due to longer commutes around the lake, and additional energy consumption associated with construction activities.

Employment

Both without-project conditions (overflow and non-overflow) would result in significant increases in local employment. Further lake level rise would induce demolition or relocation of more homes, as well as additional infrastructure work on levees, roads, and municipal systems (i.e., water supply). Some of this job creation would not occur with implementation of the alternative plans, depending on the effectiveness of the alternative in preventing further lake level rise. On the other hand, further lake level rise may have negative effects on employment due to high lake levels and consequent impacts on the local farm economy.

Regional Growth

In *Regional Economic Effects of Proposed Devils Lake Outlet,* Leistritz et al. (1999) identified four sectors that serve as the engines of the Devils Lake regional economy: agriculture, Federal activities, tourism, and manufacturing. The sectors' relative shares of final demand in the region in Leistritz were based on 1996 economic data: agriculture (48.3 percent), Federal activities (38.2 percent), tourism (10.2 percent), and manufacturing (3.3 percent). It is likely that, since 1996, these relative shares have changed significantly, but perhaps not permanently. For example, the depressed condition of the agricultural economy has likely further reduced its share. In addition, the 1996 share of Federal activities does not reflect the over $350 million of Federal emergency spending since 1993 in response to the rise of Devils Lake. Finally, tourism in the region has increased significantly as the lake has risen, largely as a result of improved fishing and hunting conditions described previously. Although these changes are potentially significant, they are not necessarily permanent. Looking out over the 50-year period of analysis, it is likely that agriculture will rebound at some point and that Federal emergency spending will subside as problems with the lake are addressed. It is likely that tourism in the lake area will continue to grow, given national trends of disposable income and leisure time.

Anticipating that the effects of an outlet on the regional economy would be relatively small does not necessarily dismiss the issue of regional growth in consideration of the effects of the alternative plans. The effects on the regional economy may be disproportionately realized in specific sectors or locations. For example, there is widespread anecdotal evidence that road construction in response to the rise of Devils Lake has had adverse effects on shopping activity in the City of Devils Lake (City). The effects on the regional economy may be small, since shoppers affected by the construction can shop elsewhere in the region. However, the regional economy could be weakened by injury to its retail core located within the City.

Economic development officials in the Devils Lake area report that the uncertainty associated with the lake has made it more difficult to attract new enterprises to the area. The perceived risk of the rising lake, which has received national media attention, may be a deciding negative factor for firms looking to relocate or expand.

Business Activity

The most important issue regarding business activity in the lake area involves the health of the retail sector in the city. The economic vitality of the city is critical to the social and economic future of the region for several reasons. First, access to the city's retail sector provides an important amenity for lake area residents. Preservation and expansion of such amenities are the best hopes to slow or reverse the depopulation of rural portions of the study area. Second, the retail sector is the core of the city economy. The jobs created by this sector are critical to the economy of the city and the region. The positive prospects created by employment in this economic hub is another important means to promote the social and economic vitality of the lake area.

The current condition of the city economy is clouded by contrary influences. The city economy has been under pressure from the depressed condition of the farm economy. The loss of farmland to the rising lake has exacerbated the drag of this sector on the regional economy. In addition, city officials report that the rise of Devils Lake and the transportation impacts, in particular, have had a very deleterious impact on the city's retail sector. City merchants report that the rising lake has affected regional shopping patterns in recent years. Many shoppers from the southern areas around the lake have discontinued their patronage of city stores because of the additional travel and inconvenience resulting from road construction. In addition, economic development officials in Devils Lake indicate that retail chains are reluctant to invest in the city, given the uncertainty of the lake's level and the consequent risk to the city's economic vitality.

Despite these negative developments, the city economy as a whole has done relatively well in recent years. Retail sales data indicate that the city continues to serve as the retail hub of the lake region. City officials maintain that this is a false economy created by the influx of over $350 million in Federal emergency funds in the last 10 years for road construction, home relocations, and other responses to the rising lake. Federal spending has undoubtedly stimulated the local economy. However, tourist visitation to the lake region has significantly increased with the expansion of the lake due to improved hunting and fishing conditions. As indicated by Leistritz, the importance of tourism to the lake area economy is growing. As estimated by Brooks and Hiltner (1999), fishermen spend up to $28 million per year in the Devils Lake area. Nonresidents account for 7 percent of open water fishing and 21 percent of ice fishing, and they spend approximately $230/day to fish on Devils Lake (Lewis et al., 1998).

To determine the balance of these diverse influences on the city economy would require detailed surveys of city shoppers and restaurant and motel patrons, as well as surveys of merchants in the City. These surveys are beyond the scope of this investigation. However, several conclusions can be drawn regarding the future of business activity in the city and the potential effects of the alternative plans.

1) Business activity in the city will be constrained by any continuation of dismal conditions in the farm economy.

2) Tourist spending in the city will continue to increase in accordance with national standards of disposable income and leisure time and would experience additional stimulation by further rise of the lake.
3) Shoppers from the south side of the lake will likely resume their patronage of city establishments unless further lake rises threaten lakeside roads, perpetuating problems with roads-as-levees as previously discussed.
4) The uncertainty associated with an uncontrolled and potentially threatening lake will continue to have adverse effects on future economic development in the city.

Property Values

As the lake has risen in recent years, property values in inundated areas and areas threatened with inundation have decreased. However, there is anecdotal evidence that some areas in the city have experienced increased property values as a result of housing demand by dislocated lakeside residents. For those residential areas subject to inundation by further rise of the lake, there is downward pressure on property values. For those areas already inundated, their value has been greatly diminished, and the adoption of conservation easements on some properties as part of the FEMA waivers has reduced the future value of those properties even in the event of a recession of the lake. For upland areas around the lake, property value has been enhanced.

Per-acre pasture and cropland values in lakeside counties have continued to increase during the lake's rise. The increase in value is somewhat surprising, given the depressed condition of the regional agricultural economy in recent years.

It has been reported that relocated houses have higher property values after their move due to improvements made as part of the relocation and the removal from exposure to the rising lake. In addition, the rising lake has in some cases reduced the aesthetics of some residential properties, as levees or raised roads block views, or road access is diminished.

The prospect of further lake rise should recreate these mixed effects on property values. A falling lake should improve valuation of areas subject to inundation by providing an additional buffer. However, the exposed lands would probably not regain their former value due to the occurrence of inundation, the damages resulting from inundation, and conservation easements that restrict future redevelopment of these previously vacated lands.

Fiscal Effects

Most of the home relocations or abandonments were conducted under the National Flood Insurance Program, administered by FEMA. HUD administered the relocations on the Spirit Lake Reservation. These programs do not require local funding matches. As a result, the fiscal impacts of home relocations on local government were limited to those associated with sales and property taxes.

There were significant impacts associated with local flood protection. Specifically, the levee protecting the City of Devils Lake was constructed by the Corps in the 1980's to an elevation of 1445 feet msl. In 1996, the levee was raised under emergency authorities to 1450 feet msl. In 2000, the levee was raised again to 1457 (providing a level of protection to 1450 msl). The initial construction by the Corps was conducted with a 60-percent Federal/40-percent non-Federal cost share. The city took full responsibility for the non-Federal share. The first raise of the levee was conducted with a 75-percent Federal/25-percent non-Federal cost share. Again, the city took full responsibility for the non-Federal share. The second raise of the levee, which cost approximately $43 million, was also performed with a 75-percent Federal/25-percent non-Federal cost share. In this case, the city was able to draw upon other funding sources to meet the non-Federal share ($10.8 million), primarily the HUD Community Development Block Grants (CDBG). In addition to providing much of the non-Federal share of the levee construction, the City of Devils Lake has incurred a variety of other expenditures in response to the rising lake. These include extensive storm sewer modifications and water supply protection. The city is planning to develop a new water supply source using its own funds. In addition, the installation of the levee required relocation of a portion of the runway of the Devils Lake Regional Airport. The city provided the non-Federal share for the runway modifications.

The City of Minnewaukan has also had significant expenditures in response to the rising lake. The city was able to use CDBG funds to provide the non-Federal share to relocate its sewer system. However, the city used its own funds to conduct a variety of road and sewer repairs. The City of Minnewaukan has spent approximately $300,000 to respond to the lake's rise.

The fiscal impacts of the rising lake on Benson County and Ramsey County have been associated with raising threatened county roads. The county governments have provided the non-Federal share of emergency road construction performed by the Federal Highway Administration. The State of North Dakota has similarly matched road construction on State roads around the lake, including State Routes 57, 20, 19, and 2. For Hazard Mitigation Projects such as the buyout of Churchs Ferry, there is a 25 percent non-Federal cost share. The non-Federal shares for such projects around Devils Lake have been divided by the county and the State using 15 percent and 10 percent shares, respectively.

Most of the counties in the study area derive their tax receipts from property taxes. The States and most of the cities in the study area derive their tax receipts from sales taxes. For Benson and Ramsey Counties, property taxes on inundated residential and agricultural lands have been reduced to levels of nonproductive land, such as wetlands. However, the total taxable value of property in these counties has increased.

Sales tax receipts of the City of Devils Lake have risen in recent years, consistent with the increase in taxable sales. As discussed previously, the changes in sales taxes may be part of a false economy stimulated by the temporary influx of Federal emergency funds. The City of Minnewaukan has also experienced increases in taxable sales during the lake's rise.

Additional fiscal pressure has been placed on the City of Devils Lake by a 2001 reduction in its municipal bond rating. This rate reduction was in response to uncertainty associated with the effects of lake levels on the city's finances. The result is that borrowing money for municipal projects has become more expensive.

If the lake continues to rise, county and local governments around the lake may again face increased local expenditures to respond to the lake and downward pressure on tax revenues. Levee protection for the City of Devils Lake to 1460 feet msl has been estimated to cost $150 million. The funding sources for the non-Federal share for another levee raise are not clear, but the State of North Dakota has reportedly committed to providing the full non-Federal share.

If the lake were to recede, local governments around the lake would receive some diminution of their fiscal pressures on expenditures and revenues. However, they would still need to pay off debt for previous expenditures. In the case of Devils Lake, the reduced influx of Federal dollars may expose the false economy of recent years, and sales tax revenues could suffer.

Public Facilities/Services

The rising lake has disrupted a variety of public infrastructure systems around Devils Lake. Storm water systems in the City of Devils Lake have required extensive modification in response to the lake's rise. Sanitary sewers in the City of Devils Lake, the City of Minnewaukan, and areas served by the Ramsey County Rural Utilities have been disrupted. Ramsey County Rural Utilities has lost approximately one-third (220 customers) of its customer base. The rising lake has squeezed this utility between higher expenditures (with higher debt service) and a smaller customer base. Some local governments have come to the support of the utility. For instance, in 2001, Creel Township committed to pay for half of a project to provide protection for Ramsey County Rural Utilities' sewer system, which services about 70 homes in the Lakewood neighborhood.

The City of Devils Lake's water supply source is located on high ground south of Tokio in Benson County. The city's water supply line has been inundated by the lake's rise. Because of potential maintenance and repair difficulties, the city is currently pursuing new water supply sources on the north side of the lake.

Further rise of Devils Lake would create additional pressure on utilities and other public facilities and services. However, many actions taken to date in response to the lake's rise have protected critical facilities from further lake rise.

<u>Downstream Water Users</u>

Future without project conditions for downstream water users are expected to be similar to the existing conditions. Water treatment plants will expand as needed to meet residential, commercial, and industrial development.

Natural Resources

Water Quality and Hydrology

Under the stochastic future, the 9.4-percent probability of a natural overflow is considered to be a low probability of occurrence. The analysis of effects to natural resources does not assume Devils Lake would overflow to the Sheyenne River. The lake could continue to rise or fall and affect existing habitat as described in Chapters 4 and 5.

The water quality of the Devils Lake complex would change with increased inflows as the lake rises and dilutes the high concentrations of dissolved solids. The model used in this analysis indicates that the TDS concentrations in the lake chain would increase from west to east. Similar patterns would be exhibited in the specific dissolved parameters including sulfate, chloride, and hardness. Water quality, in terms of TDS and the associated ion concentration, would generally improve if the lake continues to rise, or degrade if the lake level declines.

The water quality models cannot be used to directly address downstream water quality effects in a probabilistic sense. It is only practical to run the downstream water quality model for a limited number of traces selected from the 10,000 generated by the stochastic lake model. Baseline and future without-project water quality information is presented in Appendix A.

Geomorphology

Channel morphology of the Sheyenne River is relatively stable but is expected to change under the future without-project conditions. The amount of erosion due to changes in channel width is about 27 acres per year. Although meander length and amplitude are expected to decrease, it would result in increased erosion. Channel depth is expected to change by less than 1 foot. No change is anticipated in the Red River.

Terrestrial and Aquatic

Percentage land use in the broad geographic units of the study area is presented in Table 6-5. The dominant land use is agricultural.

Table 6-5 - Percent of Geographic Unit in Land Use Category

Land Use	Basin			
	Upper Basin depressions	Devils Lake to elevation 1463	Sheyenne River within ¼ mile	Red River within ¼ mile
Cropland	64	48	33	62
Woodland	1	5	18	19
Grassland	9	21	36	5
Grass-Shrub	0	0	1	0
Wetland	19	25	10	11
Urban	7	1	2	3

If Devils Lake continues to rise, about 155,000 additional acres will be inundated around Devils Lake and Stump Lake up to elevation 1459. Around Devils Lake, the majority of this acreage is currently cropland and fallow. Wetlands and grasslands are the next largest category of land use. As the lake continues to fluctuate, habitat will be gained or lost. Development around the City of Devils Lake will probably continue. Rural residential development in upland areas and areas zoned residential will probably continue.

Most of the area around Stump Lake is currently grassland and wetland with cropland/ fallow being the next largest category. These lands would be converted to open water wetland habitat with a corresponding change in wildlife. There are a number of Fish and Wildlife Service Wetland Easements and Waterfowl Production Areas located around the lake. As the lake continues to rise, the existing waterfowl staging area, aquatic resource, and National Wildlife Refuge at Stump Lake would be lost. The major change in land use in the future is expected to be caused by the fluctuating lake levels. Habitat values and wildlife populations would change in reaction to the lake levels.

As the lake continues to rise, the Devils Lake fishery resource would expand. Natural reproduction would increase, and the density and size of the aquatic resource would probably shift to larger populations of smaller fish.

If the lake falls, lake habitat would be converted to wetland or upland habitat. For example, there are currently about 47,000 acres of aquatic habitat between elevation 1440 and 1448. As the lake recedes, the water quality will worsen and the fishery will decline.

Land use in the upper basin is dominated by cropland, with about 65 percent of the sites identified as potential depression storage sites classified as such. Wetland restoration efforts and land treatment programs of various agencies will continue to be implemented. However, overall, little change in land use is expected from the existing conditions.

The future without-project condition includes the continuation of infrastructure protection measures such as levees, road raises, relocations, and abandonment. Impacts to lake and wetland communities include filling and hydrology alterations due to levee and road construction, and inundation due to ponding. Filling would encroach upon wetlands and surrounding upland plant communities, resulting in loss of functional values. Fragmentation of habitat would occur. Infrastructure protection measures could affect about 500 acres of wetland, woodland, and grassland habitat.

Soil Salinity

Soil salinity is a natural process in the upper basin. Salt accumulation in North Dakota is associated with specific hydrogeologic settings generally associated with groundwater discharge, shallow groundwater depths, and infrequent ponding. Salts accumulate in the unsaturated zone when unsaturated flow brings groundwater containing dissolved salts into the rooting zone. The attendant evapotranspirative withdrawal of pure water leaves the salts to accumulate. Although saline soils are the product of long-term hydrogeologic

conditions, salts are readily mobilized when recharge/discharge/ponding dynamics change. This condition will continue into the future.

Downstream Effects

The future without-project conditions for natural resources in the downstream areas are expected to be similar to the existing conditions. Grassland and cropland are the major land uses within ¼ mile of the Sheyenne River. The current rate of erosion along the Sheyenne River is estimated at approximately 27 acres per year. Future fishery resources are expected to be similar to existing conditions. Ecosystem restoration and other fish and wildlife management practices would enhance the resources, but overall conditions are expected to be similar to existing conditions.

Future without-project conditions along the Red River are also expected to be similar to the existing conditions. Over 60 percent of the land along the Red River is used for agriculture. Future land use along the Red River will probably be similar to existing conditions, although proportions may change somewhat. Residential and commercial development will continue along the Red River subject to zoning and development regulations.

There are initiatives by various agencies or groups to remove dams along the river and establish a riparian corridor. The Minnesota Department of Natural Resources is also trying to introduce sturgeon into the Red River.

Biota Transfer

Based on limited existing information, it appears that the biota in the Devils Lake basin are either known or considered likely to be present in the Red River basin. One possible exception is the striped bass, which has not been recorded in Devils Lake in many years. Many species have not been reported in the Red River basin, but were found to have sufficient means of overland or airborne dispersal that they could invade the Red River basin in the future. Other species were confirmed as being in the Red River basin on the basis of published scientific literature or from unpublished information provided by experts.

Devils Lake receives a tremendous amount of recreational use from users outside of the region. There is a potential for these users to introduce species into the system that would otherwise not have gotten there or would have taken longer to be introduced. The changing lake level also provides opportunities for new species to become established. Infrastructure protection measures would have essentially no effect on the risk of biota transfer.

There are substantial data gaps in a number of taxonomic groups. Because of these gaps, it is impossible to state definitively that all species currently in Devils Lake have been identified. To the contrary, it is possible that Devils Lake does harbor species that have not been analyzed. Accordingly, there may be additional species that are currently

unknown at this time. It is more likely, however, that many species not documented in either the Devils Lake or Red River basin are actually present in both.

No Minnesota-listed or other known exotic invasive species are known to occur in Devils Lake basin waters. The recent water level rise has created much new favorable habitat in Devils Lake for many species and has attracted increasing numbers of fishermen and recreational boaters. These anthropogenic factors are among the most important vectors of several harmful species in areas that they have invaded (e.g., Eurasian watermilfoil and zebra mussels). Any of these species could possibly find very favorable habitat in Devils Lake. The zebra mussel, in particular, could exploit the newly freshened habitats that have traditionally been too saline for mussels.

Almost all biota studies were carried out in the main waters of the Devils Lake and Red River basins, yet many other surface water habitats occur in each basin. A multitude of wetlands and small lakes and tributaries exist in eastern North Dakota, encompassing a broad diversity of habitat conditions. Based on the results of the literature search, it is likely that additional study of the biota of these systems would probably reveal a high level of biotic similarity between the Devils Lake and Red River basins, with the greater level of variation occurring among habitat types within these basins.

Cultural Resources

Much of the area around Devils Lake and Stump Lake has not been surveyed. Between elevations 1447 and 1460, known cultural resources sites that would be adversely affected with the rising lake levels include nine prehistoric archeological sites, three historic archeological sites, and eleven architectural/standing structure sites. There are also unverified leads to two prehistoric and five historic archeological sites and twelve architectural sites around Devils Lake between these elevations. Known cultural resources sites between elevations 1460 and 1465 around Devils Lake include one prehistoric archeological site, three historic archeological sites, and six architectural/ standing structure sites. One of the architectural sites is listed on the National Register (Benson County Courthouse in Minnewaukan). There are also unverified leads to two prehistoric archeological sites and three historic archeological sites. There are no known sites between elevations 1460 and 1465 around Stump Lake. However, there is an unverified lead to one prehistoric archeological site in this area.

Excavating borrow material, constructing temporary levees, raising the City of Devils Lake levee, and relocating houses and utilities all have the potential to adversely affect cultural resources, as do inundation and wave-caused erosion at Devils Lake and eventually Stump Lake. No effect is expected on sites along the Sheyenne River because the probability of natural overflow is relatively small.

Other States, Nations, and Tribal Resources

The fluctuating lake levels affect low income communities and lands on the Fort Totten Indian Reservation. It is not known at this time if any traditional cultural properties would be affected under the future without-project conditions.

The Province of Manitoba has established an ongoing effort to manage nutrients in the Red River and Lake Winnipeg. It is expected that these efforts will reduce phosphorus and other nutrients in Lake Winnipeg. Over the next several years, nutrient objectives will be developed and policies proposed.

There would be no major effect of the future without project conditions in the Devils Lake basin or along the Sheyenne or Red River on other States or Nations as there is anticipated to be no natural overflow under the future without-project conditions. Ongoing efforts by natural resource agencies to restore the riparian corridor along the Red River should improve downstream water quality.

Mitigation

Mitigation would be needed for several of the infrastructure protection features. The construction of levees, road raises, and associated features would result in the loss of woodland, wetland, and grassland resources. Impacts would be avoided to the extent practical by shifting alignments and minimizing the amount of fill activities. Unavoidable impacts would probably occur and would be compensated. Based on land uses affected, up to 1,000 acres of mitigation would be needed for all the infrastructure protection features up to the first level of protection. This could be accomplished by restoration of habitat or the acquisition and management of existing habitat. Adverse effects to cultural resources would be avoided to the extent practical through project design. Unavoidable effects to historic properties would have to be mitigated by further evaluation and possibly protection or data recovery.

UPPER BASIN STORAGE

Social Resources

Population Relocations

It is unlikely that enhancing the ability of the watershed to store water would induce significant population relocations. This alternative would involve impounding water in existing depressions in the watershed to detain storm water runoff. It is likely that some sale of farmland would be required to allow storage development. However, it is unlikely that there are many farmhouses and other structures located in depressions that would significantly contribute to the storage potential of the basin.

Environmental Justice (Social)

The enhancement of upper basin storage is not expected to have disproportionate effects on minority populations. Those counties potentially involved with upper basin storage (i.e., Ramsey, Towner, and Cavalier) do not have significant minority populations (see Table 6-2).

Health Effects

It is not anticipated that increased upper basin storage would have adverse health effects. However, there may be some increase in groundwater levels in certain areas of the upper basin. This could exacerbate adverse respiratory effects of mold and mildew in basements. Given the effects of the wet climate cycle, the additional increment of dampness potentially associated with upper basin storage is expected to be insignificant.

Safety Effects

No safety effects are anticipated in relation to increasing upper basin storage.

Noise Effects

No significant noise effects are anticipated in relation to increasing upper basin storage.

Aesthetic Values

No significant aesthetic effects are anticipated in relation to increasing upper basin storage.

Recreation

Recreation effects of upper basin storage are expected to be insignificant. However, wildlife and waterfowl may benefit by the creation of additional habitat.

Community Growth/Development

No significant impacts on the growth or development of communities in the watershed are expected to result from increasing upper basin storage. However, the approximately 1-foot reduction in lake levels due to upper basin storage could have some improvement for the prospects of lakeside communities and downstream communities along the Sheyenne River.

Community Cohesion

Increasing upper basin storage is not expected to affect community cohesion with the exception of dissension that may be engendered between those who favor and oppose an outlet as the preferred solution.

Land Use/Long-term Productivity

Implementation of the upper basin storage alternative would involve approximately 40,000 acres. Current land use in the depressions has not been established. However, land use in the upper basin counties is overwhelmingly agricultural. Conversion of the depressions to storage would preclude continuation of agriculture on these lands.

Controversy

Controversy about upper basin storage appears to be primarily between lakeside communities that desire an outlet and downstream communities (including those on the overflow and outlet routes) that support increased basin storage. However, landowners in the upper basin have also expressed concerns regarding this alternative. Specifically, they are concerned about the fairness of compensation for storm water detention easements on their land.

Environmental Justice (Economic)

Most of the upper basin counties, which would be affected by upper basin storage, have incomes and poverty levels that are consistent with State (North Dakota) and U.S. averages (see Table 6-4). Therefore, disproportionate economic impacts on low income and minority groups are not expected in these areas. The reduction in flood threat provided by upper basin storage should provide positive economic benefits to the low income and minority populations of Benson County.

Transportation

Upper basin storage is not expected to significantly affect transportation in the lake area.

Agriculture

Agricultural production in the upper basin would decrease in the storage areas. Farmers would be directly compensated for these losses through flowage easements, but there may be uncompensated secondary and indirect losses in the local economy due to lower farm related expenditures. Upper basin storage may also result in higher water tables. Farm productivity has been reduced during the current wet cycle by excessive moisture and salt migration into the root zone with higher water tables. It is expected that this condition could be exacerbated to some degree by greater storm water retention in the watershed.

Energy Resources/Use

Upper basin storage is not expected to have significant impacts on energy production or consumption.

Employment

Increased upper basin storage is not expected to have significant employment effects.

Regional Growth

As implied by the work of Leistritz et al. (1999), the effects of upper basin storage on regional growth are expected to be small.

Business Activity

Increasing upper basin storage may have some positive effects on business activity through modest effects on lake levels. This effect is expected to be larger than the lost expenditures related to cropland taken out of production, resulting in a net positive effect on business activity.

Property Values

No significant effects on property values in the upper basin are anticipated to result from enhanced storage.

Fiscal Effects

There may be some fiscal effects associated with conversion of agricultural lands to storage. It is assumed that the State of North Dakota would provide the non-Federal share to implement the upper basin storage alternative.

Public Facilities/Services

Enhanced upper basin storage is not expected to have impacts on public facilities or services beyond those previously discussed.

Natural Resources

Restoration of 50 percent by volume of the total possibly drained depressional area greater than 6 inches in depth in the upper basin would reduce the amount of fresh water entering Devils Lake. This would affect the water quality and, in turn, the aquatic resources of the basin. It would result in the lake reaching higher TDS and sulfate levels sooner than compared to without-storage conditions. Because of the small amount of annual inflow reduction, ranging from 13,000 (stochastic) to 16,000 (wet scenario) acre-feet, there would be little long-term effect on water quality and the aquatic resource in Devils Lake (based on restoration of 50 percent by volume of the total possibly drained depressions greater than 6 inches in depth).

This alternative would store water in depressions and convert its current land use. About 75 percent of the land use (about 30,000 acres) in the depressions is classified as cropland or grassland (see Table 6-6). Acreage estimates for land use in the drained depressions and total depression acreage vary slightly due to GIS projections of different types of data sets (DEM vs. Landsat). The upper basin storage alternative uses 50 percent by volume of the total possibly drained depressions over 6 inches in depth for the economic analysis. This alternative would take lands out of crop production, at least temporarily (based on the length of the easement).

Wetland habitat and associated wildlife values would be greatly enhanced with this alternative. There would be reduced sedimentation and turbidity downstream of the

wetlands with associated benefits to natural resources. Waterfowl uses would be improved, with associated recreational and economic benefits.

The Natural History Inventory lists seven Natural Heritage sites located in the depression storage areas in the upper basin. Potential effects would depend on the sites selected for storage.

The Upper Basin Storage alternative has a potential soil salinization hazard due to raising the water tables in areas adjacent to the restored wetlands and mobilizing subsoil salts. Areas at particular risk are existing saline wetlands and areas that are adjacent to wetlands that characteristically have a periphery of saline or saline-sodic soils.

Wetland restoration does not add salts to the landscape, but rather remobilizes existing salts that have been translocated by drainage. With wetland restoration, salts are frequently translocated back to positions in the landscape that remain saline or that were saline prior to wetland drainage. When mobilized salts accumulate in locations where salinity was not common or was not a problem before, growers would perceive a salinization problem and possibly attribute it to wetland restoration.

Table 6-6: Land Use at the Upper Basin Storage Sites

Subbasin	Land Use (acres)							Total Drained
	Cropland	Woodland	Grassland	Wetland	Urban	Other	TOTAL	Depression
Big Coulee	4,300	49	1,535	3,207	22	636	9,749	9,290
Calio	5,378	19	650	1,234	2	257	7,540	7,388
Comstock	299	2	99	211	0	65	676	631
Edmore	18,630	240	1,627	3,910	18	445	24,870	24,474
St. Joe	3,725	17	528	1,354	3	287	5,914	5,871
Starkweather	13,794	61	1,121	2,613	11	819	18,419	18,326
Mauvais-Gage 6100	6,063	75	1,990	2,418	7	413	10,966	10,696
Hurricane	1,313	52	596	1,132	3	19	3,115	3,091
TOTAL	53,502	515	8,146	16,079	66	2,941	81,249	79,767
50% of Total Acres	26,751	258	4,073	8,040	33	1,471	40,625	39,884

Source: 30 meter Landsat Thematic Mapper (TM) 1987 through 1994.

Wetland information from U.S. Fish and Wildlife Service National Wetlands Inventory (NWI).

Total land use acreage (LTM) and total drained depression acreage (West) do not agree due to differences in resolution of imagery.

Other category includes areas classified as wetland on TM but not identified as NWI wetland.

Some of the NWI wetlands could be seasonal and consist of cropland or grassland.

50 percent of total acres may slightly overestimate land use affected because the evaluation was based on volume of storage, not acres of depressions.

Restoration should be focused primarily on candidate wetlands in the "None/Slight" and "Low" salinization hazard classes. Few salinization problems are likely to be perceived in these wetlands, and they represent the majority of the recoverable storage volume in the Upper Basin. However, restoration of candidate wetlands would likely have to take into consideration members of all salinization hazard groups due to uncertainties in land acquisition, the need to restore wetlands in certain locations, and the need to focus on larger wetlands with greater storage potential. Detailed on-site investigations for each potential restoration site would be required to better define potential salinization hazards associated with restoration.

Of the 127,000 acre-feet identified, over 66,000 acre-feet are in the None/Slight soil salinity hazard category. Therefore, restoration of 50 percent of the potential storage volume (over 60,000 acre-feet) is attainable with a minimum of salinization hazards.

There would be no natural resource effects downstream with the upper basin storage alternative.

Cultural Resources

While the historic literature has provided dozens of leads to historic and architectural sites in the Upper Basin area, few prehistoric, historic, and architectural sites have been field verified and recorded. The few previous cultural resources surveys in the Upper Basin covered only limited areas involving gravel/borrow pits, bridge replacements, wildlife management area projects, and rural water and utility lines. The Towner County Courthouse in Cando and the Pierson Farm south of York are the only properties listed on the National Register of Historic Places in the Upper Basin, which encompasses parts of Benson, Cavalier, Pierce, Ramsey, Rolette, and Towner Counties.

Other States, Nations, and Tribal Resources

Upper basin storage would have no effect on downstream resources of the Spirit Lake Tribe, Minnesota, or Canada. Many downstream interests have favored this alternative.

Upper basin storage would have about a 1-foot effect on the 10-percent probability lake level and little effect on water quality or aquatic resources; therefore, effects on the Spirit Lake Tribe around Devils Lake would be minor. Portions of the reservation would benefit from lower lake levels.

Mitigation

It is anticipated that mitigation for effects to natural resources would not be required for upper basin storage or the restoration of drained and partially drained wetlands. The natural resource benefits due to upper basin storage would outweigh any adverse effects. There would be some adverse effects to social and economic resources. Cultural resources may be adversely affected and that would require mitigation. Some cultural effects could be avoided through project design. Effects to historic properties would require further evaluation and possibly protection or data recovery.

EXPANDED INFRASTRUCTURE PROTECTION

Social Resources

Population Relocations

Expanded infrastructure measures could result in significant population relocations. Installation of new levees on the landward side of existing roads-as-levees could require some relocations, depending on the levee alignments. In addition, the flooding of land between the roads-as-levees and the new levees to equalize hydraulic pressure on the road embankments would inundate some areas that currently are protected by the embankments and could induce relocations in some cases.

Environmental Justice (Social)

The construction of levees landward of the roads-as-levees could affect Native Americans disproportionately. Some of the lands currently protected by the roads-as-levees are located in the Fort Totten Indian Reservation, particularly in the vicinity of St. Michael. Native Americans on the Reservation would be expected to be direct beneficiaries of levee protection. However, construction of expanded infrastructure could potentially generate large volumes of construction vehicles passing through the Fort Totten Indian Reservation during the construction period. The resolution of 2000 Census data does not permit accurate alignment with areas potentially affected by the expanded infrastructure alternative. The net effects of this alternative on Native Americans may be positive, but there is potential that Native Americans may be disproportionately affected during construction.

Health Effects

Expanded infrastructure protection is not anticipated to have adverse health effects.

Safety Effects

Expanded infrastructure may significantly improve safety levels for some areas around the lake. New levees on the landward sides of existing roads-as-levees would be installed for safety purposes. The risks of failure of the new levees would be much smaller than risks of failure of the road embankments serving as levees. Consequently, there would be a significant increase in safety for those living in areas protected by the roads-as-levees and for those motorists traveling along the roadways.

The physical features of this plan are not expected to cause significant safety effects. As with all construction activities, there are risks associated with the operation of heavy equipment and the movement of large construction materials. However, all construction contractors would be required to develop and institute safety plans.

Noise Effects

The construction of levees landward of roads-as-levees could have some noise effects. It could produce significant short-term noise effects at the construction site and along routes used for construction transport of equipment and materials. This noise would be short-term with no long-term consequences.

Aesthetic Values

Expanded infrastructure around the lake may have some aesthetic impacts associated with blockage of lake vistas by new levees on the landward side of the roads-as-levees. There may be potential aesthetic impacts of construction activities as part of implementation of this plan.

Recreation

Recreation effects of expanded infrastructure are expected to be insignificant. It is unlikely that levees built landward of the roads-as-levees would affect access to the lake. Construction activities associated with this plan could temporarily affect the quality of recreation on the lake due to visual or noise effects, and may affect the quantity of recreation by temporarily impeding recreation access.

Community Growth/Development

The expansion of infrastructure around the lake would likely have a significant impact on the growth or development of some communities around the lake. For example, a portion of the community of St. Michael on the southern shore of the lake is currently protected by a road-as-levee. The installation of a new levee to replace this protection would greatly improve the prospects for growth and development of this community by reducing the risk of inundation if the road embankment failed.

Construction activities associated with this plan would likely improve the growth and development prospects of some communities. For example, the City of Minnewaukan and the City of Devils Lake would likely benefit from the influx of jobs and funds associated with construction activities. The increased activity, suggesting new money coming into the community and solution of the community problems, would enhance the ability of affected communities to retain young people, create jobs, and attract new investments.

Community Cohesion

The expansion of infrastructure around the lake is not expected to have significant impacts on community cohesion. The roads-as-levees are recognized as performing a function for which they were not designed or constructed. There seems to be consensus that new levees would be required to replace roads-as-levees if the lake continues to rise and if an outlet is not constructed.

Land Use/Long-Term Productivity

Expanded infrastructure at Devils Lake is not expected to affect land use around the lake with the exception of land needed for the footprints of new levees landward of the roads-as-levees.

Environmental Justice (Economic)

Most of the lake area counties, which would be affected by expanded infrastructure, have incomes and poverty levels that are consistent with State (North Dakota) and U.S. averages. Therefore, disproportionate economic impacts on low income and minority groups are not expected in these areas. However, Benson County is exceptionally low in terms of median income and relatively high in terms of percentage of county population living in poverty. Some of the lands currently protected by the roads-as-levees are located in the Fort Totten Indian Reservation, particularly in the vicinity of St. Michael. Native Americans on the Reservation would be expected to be direct beneficiaries of levee protection. However, construction of levees landward of the roads-as-levees could affect Native Americans disproportionately during the construction period. Unfortunately, the 2000 Census data is not precise enough to permit accurate alignment with areas potentially affected by the expanded infrastructure alternative. The net effect of this alternative on Native Americans may be positive, but there is a potential that Native Americans may be disproportionately affected by adverse effects during construction.

The lake area counties are most likely affected by the physical features of this plan or by construction activities. Most of the lake area counties, with the exception of Benson County, have incomes and poverty levels that are consistent with State (North Dakota) and U.S. averages. All efforts will be made during any construction to avoid short-term economic effects on low income and minority populations. Low income and minority populations may actually benefit during the construction process through the provision of construction jobs and multiplier effects of expenditures in the local economy.

Transportation

The expanded infrastructure alternative would reduce or remove hydraulic pressure on lakeside embankments for roads serving as levees. As previously discussed, this would increase safety of motorists along these roads and maintain transportation along these routes. Construction activities could significantly affect the volume of traffic along access routes during the construction period. Heavy construction vehicles could adversely affect roadways, increasing local maintenance costs along these routes.

Agriculture

The agricultural effects anticipated to result from implementation of expanded infrastructure would include the loss of farmland associated with the footprints of new levees and inundation of lands currently protected by the roads-as-levees.

Energy Resources/Use

Expanded infrastructure is not expected to have significant impacts on energy production or consumption.

Employment

The potential employment effects of expanded infrastructure as evaluated by Leistritz et al. (1999) will be described in the following section as part of the regional economic effects.

Regional Growth

As discussed by Leistritz et al. (1999), construction-related effects are expected to be one of the principal impacts on the regional economy. However, even the economic effects of construction are not expected to exceed 2 percent of total regional gross business activity or employment.

Business Activity

Installing levees landward of the roads-as-levees would help promote the return of shoppers from south of the lake to the City of Devils Lake by reducing risks and disruptions associated with travel on these roads. Construction of this plan would temporarily stimulate business activity in the lake area and in the City of Devils Lake as the economic hub of the area.

Property Values

Expanded infrastructure could have mixed effects on property values behind roads-as-levees. For those areas between the roads and new levees, their inundation would greatly reduce their value. However, for those areas behind the new levees, their protection from future inundation could significantly increase their value. Construction of this plan could temporarily reduce the value of nearby properties.

Fiscal Effects

Expanded infrastructure could have some fiscal effects on local governments by inundating areas currently protected by roads-as-levees with consequent reductions in property tax revenues to county governments. It is assumed that the State of North Dakota would provide the non-Federal share of project costs. There may be a temporary increase in sales tax revenues associated with construction expenditures.

Public Facilities/Services

Construction of levees landward of the roads-as-levees is not expected to affect public facilities or services beyond those previously discussed.

Natural Resources

The impacts resulting from this alternative would be similar to the proposed future without-project conditions, differing only because road raises would function as dams and eliminate inundation on one side of the road. The alternative would have limited effect on lake levels or on the probability of a natural overflow.

If existing road raises were reconstructed to function as dams, they would require road reconstruction or additional fill material on the lake side of the road. This would result in additional impacts to aquatic or terrestrial resources. Impacts would result from increased turbidity and sedimentation during construction and clearing of vegetation to tie into higher ground. In most cases, these impacts would be temporary except in the case of permanent fill in wetlands or other natural habitats. Construction of roads as dams would result in increased lake levels. Inundation by the lake would be reduced on about 3,800 acres, but interior drainage would pond water on some of these areas.

Impacts from expanded infrastructure protection measures to aquatic and terrestrial resources would occur due to loss of vegetation and aquatic resources from fill, excavation, removal of vegetation, increased sedimentation, relocation of structures, and turbidity. Most of the impacts would be temporary or could be mitigated by plantings or wetland restoration. Relocation of structures would affect other habitats, but would result in reclaiming others. There would be little difference from the future without-project conditions.

Impacts to lake and wetland communities include filling and hydrology alterations due to levee and road construction, and flooding due to ponding. Filling would encroach upon wetlands and surrounding upland plant communities, resulting in loss of functional values. Fragmentation of habitat would occur. Expanded infrastructure protection measures could affect about 3,400 acres of wetland, woodland, and grassland habitat.

There would be no effects in the upper basin or downstream in the Red River basin with this alternative.

Cultural Resources

Effects would be the same as for future without project conditions. There would be additional impacts to cultural resources due to measures involving roads acting as dams where earth dams would be constructed and at borrow areas.

Other States, Nations, and Tribal Resources

Expanded infrastructure protection measures would have no effect on areas downstream of the Devils Lake basin along the Sheyenne or Red River. There would be no effect on Minnesota or Canada.

Expanded infrastructure protection measures could be implemented on the Spirit Lake Tribe properties and reservation, resulting in long-term benefits and primarily short-term impacts.

Mitigation

Mitigation would be needed for the expanded infrastructure protection features. The construction of levees, road raises, and associated features would result in the loss of woodland, wetland, and grassland resources. Impacts would be avoided to the extent practical by shifting alignments and minimizing the amount of fill activities. Unavoidable impacts would probably occur and would be compensated. A preliminary estimate of the amount of mitigation needed for the expanded infrastructure protection features for roads-as-levees is about 6,700 acres. This could be accomplished by restoration of habitat or the acquisition and management of existing habitat. Adverse effects to cultural resources would be avoided to the extent practical through project design. Unavoidable cultural effects on historic properties would have to be mitigated by further evaluation and possibly protection or data recovery.

OUTLET PLAN (Pelican Lake Preferred Alternative)

Social Resources

Population Relocations

There are approximately 1,828 people living in Census block groups intersected by the Pelican Lake outlet route. The outlet would comprise a small corridor through these block groups, and a relatively small portion of this population would be affected by the outlet. Detailed design of the outlet route and pumping facilities has not yet been developed. However, it is unlikely that any significant population relocations would be induced by the Pelican Lake outlet because of the rural character of this area.

Environmental Justice (Social)

According to officials of the Fort Totten Indian Reservation, the outlet route would not affect any tribal trust lands within the reservation. As a result, the outlet route would not be expected to have disproportionate impacts on Native American populations. Construction activities associated with the outlet, however, could have disproportionate effects on minority populations. Construction of an outlet could potentially generate large volumes of construction vehicles passing through the Fort Totten Indian Reservation during the construction period. Construction activities could also generate much-needed jobs for Native Americans on the Reservation. Multiplier effects of construction expenditures could also help the Reservation economy. No significant impacts to Native American subsistence fishing on Devils Lake would be anticipated with lake level fluctuations associated with outlet operation.

Health Effects

An outlet from Devils Lake could affect human health primarily through water quality effects similar to, but less severe than, those for an overflow. The NED analysis anticipates investments in water supply infrastructure that will be required with implementation of an outlet. Although there may be some potential health effects before the investments are complete, these effects are expected to be insignificant due to anticipation of the water quality effects and to the relatively small scales of water supply systems involved.

Safety Effects

A constrained outlet is not expected to exacerbate flooding problems along the Sheyenne River or Red River. Some flooding may be inevitable, though, due to the inability to quickly control discharges into the Sheyenne River in response to heavy localized rainfalls. Thus, there may be safety effects for some downstream residents. Some residents have expressed concern that higher summer flows in the Sheyenne River could pose a hazard for swimmers, canoeists, or others in or along the river who are accustomed to the modest summer flows currently experienced. Ramping of flows would reduce the safety concerns associated with the operation of an outlet.

There are not expected to be significant safety effects associated with the physical features of the outlet. As with all construction activities, there are risks associated with the operation of heavy equipment and the movement of large construction materials. However, all construction contractors would be required to develop and institute safety plans.

Noise Effects

Operation of the outlet pumps could produce significant levels of noise. However, for multiple reasons, including noise, the pumps would be enclosed in a pumphouse. This will limit pumping noise. The noise effects of the high-head pumping operations are expected to be insignificant due to the potential locations of the pumping stations. It is expected that a Pelican Lake pumping station would be located north of Minnewaukan. This location is rural, population densities are very low and the few nearby residents would not be expected to experience significant noise effects. In the development of plans and specifications for the pumping facilities, noise would be incorporated as an environmental feature, and appropriate noise abatement measures would be incorporated as needed.

As in the case of levee construction or road raising, construction of the outlet could produce significant short-term noise effects at the construction site and along routes used for construction transport of equipment and materials. However, these effects would have no long-term consequences.

Aesthetic Values

An outlet from Devils Lake should have minimal impact on study area aesthetics. With the exceptions of the pumping stations and water control structures, the outlet facilities should be almost entirely underground. To the extent that outlet releases accelerate erosion-deposition patterns along the Sheyenne River and damage the riparian corridor as discussed above, there may be some aesthetic impacts associated with the outlet releases.

Some Spirit Lake Sioux living on the Fort Totten Indian Reservation object to a Devils Lake outlet on a spiritual basis, feeling that the lake level should be allowed to fluctuate freely and naturally. These individuals may be offended or disturbed by the management of the lake levels with an outlet, and their appreciation of the aesthetics of the lake may be reduced as a consequence.

Recreation

An outlet to the Sheyenne River could also affect recreation along the river by creating increasing flows and perhaps creating hazardous conditions for canoeists and swimmers. It could also reduce the aesthetics of the riparian zone by accelerating erosion-deposition processes along the river or by affecting vegetation with higher ambient salinity levels.

Construction activities associated with the outlet could temporarily affect the quality of recreation on the lake due to visual or noise effects, and may affect the quantity of recreation by temporarily impeding recreation access.

Community Growth/Development

The outlet plan could have significant impacts on the growth and development of communities downstream of the outlet route. An outlet is perceived as a positive development for lakeside communities, such as the Cities of Devils Lake or Minnewaukan. However, an outlet is perceived by some residents of downstream communities as potentially having a negative impact on future development of their communities, due to the transfer downstream of floodwaters. It is unlikely that a constrained outlet would have significant adverse effects on downstream communities. This outlet would be operated specifically to avoid adverse water quality and flooding effects.

Construction activities associated with the outlet would likely improve the prospects of some communities for growth and development. For example, the Cities of Minnewaukan and Devils Lake would likely benefit from the influx of jobs and funds associated with construction activities. The increased activity, suggesting new money coming into the community and a solution of the community problems, would enhance the ability of affected communities to retain young people, create jobs, and attract new investments.

It is supposed that a constrained or unconstrained outlet could also have negative impacts on lakeside communities if the lake keeps rising despite the outlet. The dashed expectations could be more detrimental to community vitality than if they never had an outlet.

Community Cohesion

There is less cohesion among communities along the Sheyenne River regarding an outlet from the lake. Some residents of downstream communities believe that an outlet would have deleterious effects on their communities by shifting flooding problems from the lake communities to them. This group of people tends to support increased upper basin storage as the solution to the rising lake, thereby eliminating the need for an outlet. Others along the Sheyenne River are more sympathetic to the communities facing flooding problems around Devils Lake. As a result, there is some dissension in downstream communities regarding the acceptability of an outlet from Devils Lake.

Land Use/Long-Term Productivity

An outlet from Devils Lake would affect land use along the outlet route. The Pelican Lake outlet would directly affect approximately 133 acres along its 22-mile route.

Controversy

Issues about an overflow and an outlet are intertwined. There is additional controversy associated with the outlet route through Peterson Coulee. Some landowners along this route have formed the Peterson Coulee Outlet Association to oppose an outlet through the coulee. They also cite upper basin storage as the solution to lake level rise. They perceive the State as rushing to build an outlet without full consideration of upper basin storage as a solution that would be less damaging to downstream interests.

Environmental Justice (Economic)

The downstream counties in North Dakota and Minnesota, which would be affected by a Devils Lake outlet, have incomes and poverty levels that are consistent with their State and the U.S. averages. Therefore, disproportionate economic impacts on low income and minority groups are not expected.

The lake area counties are most likely affected by the physical features of the outlet or by construction activities. As discussed above, most of the lake area counties, with the exception of Benson County, have incomes and poverty levels that are consistent with State (North Dakota) and U.S. averages. Construction of an outlet could potentially generate large volumes of construction vehicles passing through the Fort Totten Indian Reservation during the construction period. All efforts will be made during construction to avoid any short-term economic effects on low income and minority populations. Low income and minority populations may actually benefit during the construction process through the provision of construction jobs and multiplier effects of expenditures in the local economy.

No significant impacts to Native American subsistence fishing on Devils Lake would be anticipated with lake level fluctuations associated with outlet operation.

Transportation

No significant lakeside transportation effects are anticipated with implementation of a Pelican Lake outlet. However, an outlet could exacerbate flooding along the Sheyenne River with consequent damage to transportation infrastructure, including roads and bridges.

Construction activities related to the outlet could significantly affect the volume of traffic along access routes during the construction period. Heavy construction vehicles could adversely affect roadways with increased traffic.

Agriculture

An outlet from Devils Lake would affect agricultural lands along its route. The Pelican Lake outlet would directly affect approximately 133 acres along the 22-mile route.

As in the case of an overflow, farms that withdraw water from the Sheyenne River or the Red River for irrigation could suffer reduced crop yields from the lower river water quality associated with an outlet. Exacerbated flooding in the Sheyenne River could damage agricultural property, including lands, equipment, and structures; however, the purchase of flowage easements has been included in the project first cost to address these impacts. Also, higher flows in the river could affect some farms that straddle the river. These river crossings may be impeded or prohibited by additional river flow associated with an overflow.

Adverse impacts also may be felt by farm/ranch operators directly affected by easement acquisition of acres needed to mitigate the environmental impacts of the outlet. The acres targeted for acquisition are generally of wooded, grassland, or wetland cover type, which are normally used for pasture or hayland. An effort was made to avoid acquisition of cropland. But, these acres would be acquired in fee title meaning that the former owners would not be allowed to use the land in any manner. Sixty parcels have been identified for acquisition totaling 7,532 acres (average of 125.5 acres per parcel ranging in size from 4 acres to 508 acres; 14 parcels exceed 160 acres in size). The intent is to obtain 6,032 acres from this pool. The actual areas acquired would be dependent on negotiations and field analysis of lands. Overall, the impact to the region as a whole may be minor. However, the impact of acquiring mitigation acres on individual operations may vary from minor to substantial depending on the amount of acres acquired relative to the size of the operation and how the particular acres acquired affect their logistical operations. Individual operations may be scaled down and/or operating procedures may change.

Energy Resources/Use

The outlet pumps would require significant energy to operate. The pumping station would require installation of a high-voltage line to the facility.

Employment/Regional Growth

As described in discussions of the work of Leistritz et al. (1999), the effects of an outlet on regional growth are expected to be small. Construction-related effects, though, are expected to be one of the principal impacts on the regional economy. However, even the economic effects of construction are not expected to exceed 2 percent of total regional gross business activity or employment.

Business Activity

An outlet from Devils Lake would promote economic development in the City of Devils Lake and stimulate business activity by reducing uncertainty and risks to commercial enterprises associated with rising lake levels. An outlet would also help restore regional shopping patterns that allowed the city to serve as the retail center for areas south of the lake. The construction of an outlet would temporarily stimulate business activity in the lake area and in the City of Devils Lake as the economic hub of the area.

Property Values

An outlet from Devils Lake could diminish property values along the Sheyenne River. The potential for adverse impacts to property values would be based on damage in the riparian zone, exacerbated flood risks, and reduced water quality for agriculture or recreation. Properties affected would be limited to those lands along the river. An outlet could diminish property values along the outlet route by: 1) reduced agricultural use of those lands, 2) requisite access to maintain the outlet facilities, or 3) reduced aesthetics.

Construction of an outlet could temporarily reduce the value of nearby properties.

Fiscal Effects

An outlet from Devils Lake would not be expected to have significant fiscal effects on communities downstream along the Sheyenne River. However, an outlet could result in positive fiscal effects on lakeside counties and cities. There may be a temporary increase in sales tax revenues associated with construction expenditures. It is assumed that the State of North Dakota would provide the non-Federal share of outlet costs.

Counties may experience minor adverse fiscal impacts as a result of acres required for mitigation of outlet impacts being converted from private ownership to public ownership via fee title easements. While owners will be compensated, counties would no longer receive any property tax revenue from these lands. This impact is not expected to be significant since less than 1 percent of acres in any one county will be acquired for

mitigation purposes (see table below). Approximately 7,500 acres along the Sheyenne River from the outlet to the Red River have been identified as potential mitigation areas. A total of 6,032 acres of mitigation is needed and potentially would be obtained from these areas. The lands actually acquired would depend on further analysis. These potential mitigation areas are distributed by county as follows:

County	Total Acres	Mitigation Acres	Percent
Benson	883,800	694	0.08%
Eddy	403,200	2,563	0.64%
Nelson	628,500	927	0.15%
Griggs	453,100	1,363	0.30%
Ransom	552,300	589	0.11%
Richland	919,700	1,287	0.14%
Cass	1,129,600	110	0.01%
Total	4,970,200	7,533	0.15%

Public Facilities/Services

An outlet from Devils Lake is not expected to affect public facilities or services.

Downstream Water Users

Based on analysis of the available data regarding the operations of the eight affected municipal water treatment facilities, a computer spreadsheet model was developed to estimate the annual increase in cost that can be expected at each facility due to the change in water quality. Hardness was identified as the major water user concern associated with an outlet. Ion exchange would be needed to treat sulfates but, due to the limited water quality effects resulting from a 300-mg/l sulfate constrained outlet, it was determined that softening was adequate treatment for water users. Cost increases would result from increased softening costs (due to increased chemical feed rates and increases in sludge handling and disposal), and increased capital and operations costs if treatment or an alternative water supply is required to restore the treatment facility finished water quality to without-outlet conditions.

Modeling showed the total annualized cost for increased softening would range from $25,000 per year to $56,000 per year, depending on the modeled water quality future. The total annualized cost for capital improvements or alternate source water development required to bring the with-outlet product water to the water quality of without-outlet product water ranged from $1,757,000 per year to $3,304,000 per year. Sulfate concentration is not a major concern along the Sheyenne or Red Rivers with the Pelican Lake outlet. In most cases, treatment by ion-exchange was found to be the least-cost alternative if without-outlet product water quality is required.

Industrial Water Users - Interviews were conducted with all of the industrial river water users along the Sheyenne River and the Red River of the North. Two were expected to incur increased costs as a result of the Devils Lake outlet operations. The sugar beet processing facility is expected to have increased lime softening costs as a result of the outlet. The coal-fired power plant's increased costs relate to additional need for ion exchange water purification for boiler water. On the basis of one of the sample water quality data sets, annualized costs would be expected to be $1,200 per year for the sugar beet processing facility, and $30,700 per year for the power plant.

Other Permitted River Water Users – Including municipal and industrial permits, 201 permits were listed along the affected reaches of the Sheyenne and Red Rivers. In 96 percent of the cases, the water was used for irrigation (which is defined to include livestock watering); the remaining 4 percent of the permits were for other uses. Interviews were conducted with a representative sample of 20 percent of the permit holders. Approximately half of those interviewed expressed concern over possible changes in water quality, but approximately 25 percent were unconcerned. Research into salinity effects on plants and animals showed that limited potential exists for adverse effects. Potentially affected uses were identified—these include irrigation of approximately 17 square miles of corn, certain plants and vegetables, and possibly fish and livestock production. Water supply alternatives considered included a change to less sensitive crops, private well installation, connection to municipal or rural water supply systems, and relocation. However, if an alternative water supply is in fact required, payment to compensate for reduced yields may be the only practical option.

The U.S. Fish and Wildlife Service is listed as having 10 permits, although this study identified only two fish hatcheries (Bald Hill and Valley City hatcheries, both located in Barnes County, North Dakota). Modeling for the outlet indicates the TDS concentration would exceed 600 mg/l 48 percent of the time (base condition is 20 percent) and would not exceed 800 mg/l. This TDS concentration is below the threshold level for fish reproduction. High TDS levels slow the growth of juvenile fish and limit natural fish reproduction. Increased turbidity (with silts 0.5 micron and below) may hinder fish production at the hatchery as suspended silts create operational problems. It is not expected that water quality changes would appreciably affect hatchery operations.

The hatchery takes 100 percent of its water supply for hatchery operations directly from the Sheyenne River. Higher sulfates present a known corrosive problem to hatchery equipment. The hatchery is anticipating replacing the equipment with non-corrosive equipment. This replacement may occur slightly sooner due to degraded water quality with an outlet.

Extended high flows from Baldhill Dam may result in problems related to the ability to drain the fish ponds at Baldhill Dam and Valley City National Fish Hatcheries. Flows around 700 to 800 cfs will prevent the ponds from being drained. In a typical year, juvenile fish are removed and ponds drained in the May to June time frame coinciding with daphnia (a zooplankton that provides a primary forage base for the fish) depletions. If high flows prevent this procedure, the fish will consume one another as a primary food

source, resulting in a lower production. Baldhill Dam flows could be modified to alleviate this concern.

Non-Permitted River Water Users - A principal difficulty in characterizing the potential effects on non-permitted users was locating those users; agency listings of such users are not available. Permits for river water use are required only when certain withdrawal thresholds are reached. Twenty-five non-permitted users along the affected reaches of the two rivers were located and interviewed. Most of the non-permitted group use the water for watering lawns, private landscape, or relatively small-scale fruit and vegetable plots. Nine of those interviewed reported using the water for livestock. Water supply alternatives identified included a change to less sensitive crops, private well installation, connection to municipal or rural water supply systems, and relocation.

Natural Resources

The determination of effects from operating an outlet from Devils Lake is dependent on the conditions assumed to persist into the future and the location of the outlet. These two conditions affect the quality of the water to be discharged into the Sheyenne River and flows that are in the Sheyenne River, which in turn affects the assumptions concerning the operation of an outlet. Until as late as September 2001, the analysis of impacts on natural resources assumed that the outlet would originate in West Bay. Because of the uncertainty as to which outlet operation plan would be proposed for design, 300 cfs or 480 cfs - constrained or unconstrained, the analysis of natural resources effects was designed to bracket the potential effects for the two moderate lake scenarios selected for analysis. Analysis design assumed that if drier conditions persisted (the 1450 lake elevation trace), operation of a 300-cfs outlet, constrained by water quality and channel capacity, would reflect the lower limits of the potential effects. If wetter conditions persisted (the 1455 lake elevation trace), it was assumed that the operation of a 480-cfs outlet, unconstrained by water quality or channel capacity, would reflect the potential upper limits of the operation of an outlet.

The best outlet plan, the Pelican Lake 300-cfs/300-mg/l sulfate constrained outlet plan, does not originate in West Bay and falls somewhat outside the bounds of this analysis. The water quality effects on aquatic resources would likely be very similar to those identified with the West Bay 300-cfs outlet, constrained by water quality and channel capacity. However, since a Pelican Lake outlet captures the fresh water flowing into Devils Lake, the outlet would have substantially higher flows, and the effects of increased flow on aquatic habitat in the Sheyenne River would likely be closer to the effects identified with the West Bay 480-cfs outlet. In lieu of additional detailed modeling, the water quality effects of the 300-cfs constrained operation and the flow effects of the 480-cfs unconstrained operation were used to evaluate the potential effects of the Pelican Lake outlet on aquatic resources.

The adopted approach may underestimate the in-lake effects, since the amount of fresh water entering Devils Lake would be less than that assumed in previous evaluations. Likewise, downstream effects may be slightly overestimated. However, this analysis

does identify the areas and relative degree of expected impacts that could be expected with the Pelican Lake outlet, and is the appropriate level of detail for decision-making at this time. Additional analysis, and possibly additional NEPA documentation, would be needed to address any changes in operation or mitigation features.

Devils Lake Effects

Water Quality and Hydrology

The effects of an outlet on Devils Lake elevations and water quality for a wet scenario and moderate future are shown in Appendix A. The information shows that there would be little effect on TDS and sulfate levels in the lake. If wet conditions prevail, the lake would reach lower levels and water quality conditions about 3 years sooner than if no outlet had been operated. The effects are more pronounced and quicker under dry conditions. Appendix A provides data on water levels and water quality under various conditions with and without an outlet. Peak readings may vary slightly from those presented in the Fish and Wildlife Service Coordination Act Report because of data taken from different river mile locations when running the HEC 5Q model. These differences do not affect the results of the impact analysis.

Aquatic Impacts

Overall, the operation of a Pelican Lake outlet from Devils Lake would have some effect on the availability, quality and recovery of both aquatic and terrestrial habitat in and around Devils Lake. These changes are associated primarily with the timing of specific habitat conditions at most elevations in and around Devils Lake, and are not considered to be of sufficient magnitude as to appreciably affect the terrestrial or aquatic biological productivity.

Using the 1455 scenario as an example, the operation of an outlet may affect the eventual elevation that the lake reaches by about 3 feet. This would reduce the amount of terrestrial habitat affected by rising levels. Operation of an outlet would also reduce the amount of time some vegetation is inundated since the lake would recede quicker, which may hasten successional recovery. A review of the various lake trace simulations indicates that while water would recede off inundated terrestrial habitat as much as 7 years earlier with the operation of an outlet, generally the difference at most elevations is 2 to 3 years. This is not considered to represent an appreciable change in habitat quality or availability when compared to the without project condition.

An outlet would have a similar effect on the availability and quality of aquatic habitat in Devils Lake. The accelerated decline in the lake elevation would represent a loss of spawning or nursery habitat earlier than expected, but again only a 2- to 3-year difference at most elevations when compared to the without-outlet condition. Water quality simulations for the Pelican Lake alternative indicate that operation of an outlet would result in an increase in TDS levels, but not of such magnitude as to appreciably affect the aquatic resource in Devils Lake.

Terrestrial Resources

Construction of an outlet would have limited short-term effects on natural resources along the outlet alignment. Above Minnewaukan, the open channel would parallel Highway 281 and would be lined, if needed, to avoid any groundwater effects on wetlands. Most of the area along Highway 281 is currently open water. There is limited channel excavation needed along Highway 281 to connect to the pumping station. Land use along other portions of the alignment is primarily cropland or grassland. If any wetlands are impacted they would be restored when outlet operation ceases resulting in no impact. Use of a buried pipeline along most of the route would result in minimal effects to natural resources. This is considered a temporary impact and does not require mitigation.

As part of the outlet, about a 60-acre re-regulation reservoir is needed near the divide to the Sheyenne River. The present design impacts less than 2 acres of wetland. The remaining land use is primarily grazed or hayed grassland. If any Fish and Wildlife Service wetland easements are impacted along the outlet alignment, they would be compensated for in accordance with the Refuge Improvement Act. This would be investigated when the final design is prepared.

An outlet would result in lower lake levels around Devils Lake, which would hasten succession. This would result in benefits to terrestrial habitat and wildlife populations at the expense of aquatic habitat and populations.

Upper Basin Effects

The Dry Lake diversion feature of the plan would divert additional water into the Chain of Lakes upstream of Pelican Lake. This would occur primarily during drier conditions or when there is lower flow in Mauvais Coulee. Additional flow may result in higher lake levels for a longer period of time, which could affect habitat conditions for waterfowl, primarily in the Lake Alice National Wildlife Refuge. A determination of compatibility with refuge operations would be requested from the U.S. Fish and Wildlife Service when a more detailed design is completed.

An alternative to the use of the chain of lakes is a diversion channel directly from Dry Lake to Mauvais Coulee. This alternative would be pursued if compatibility with the Lake Alice Refuge were determined to be an issue. The channel would be constructed in grassland, cropland, and wetland. Impacts would include loss of habitat and associated wildlife values. There would be no effect to the upstream lakes including Lake Alice. This alternative to the Dry Lake feature has not been fully designed or evaluated.

Sheyenne River Effects

Flow

Operation of the Pelican Lake outlet would result in a substantial change in the flow regime of the Sheyenne River. Discharges of up to 300 cfs over a major portion of the summer would represent a five- to tenfold increase in summer/fall flows along the Sheyenne River. Increased flows throughout the summer would result in changes in river stage on the Sheyenne and Red Rivers. The approximate changes in river stage at various locations are as follows: 1.5 feet at Sheyenne, 1 foot at Cooperstown and Valley City, and 0.5 foot at Lisbon, Kindred, Oslo, and Grand Forks and at the international border. These stage increases would result if the flow stays within the channel.

Examples of the amount, duration, and timing of flow from Devils Lake are presented in Figure 6-2 (shown for the Cooperstown area along the Sheyenne River). This indicates when an outlet would be operating. It shows that the outlet could result in up and down flows with sudden and extreme fluctuations in flow for much of a 50-year period of operation. These are the types of situations that make it difficult for species to adapt to habitat conditions. See Appendix A for more information on water quality and flow at various control points along the Sheyenne and Red Rivers.

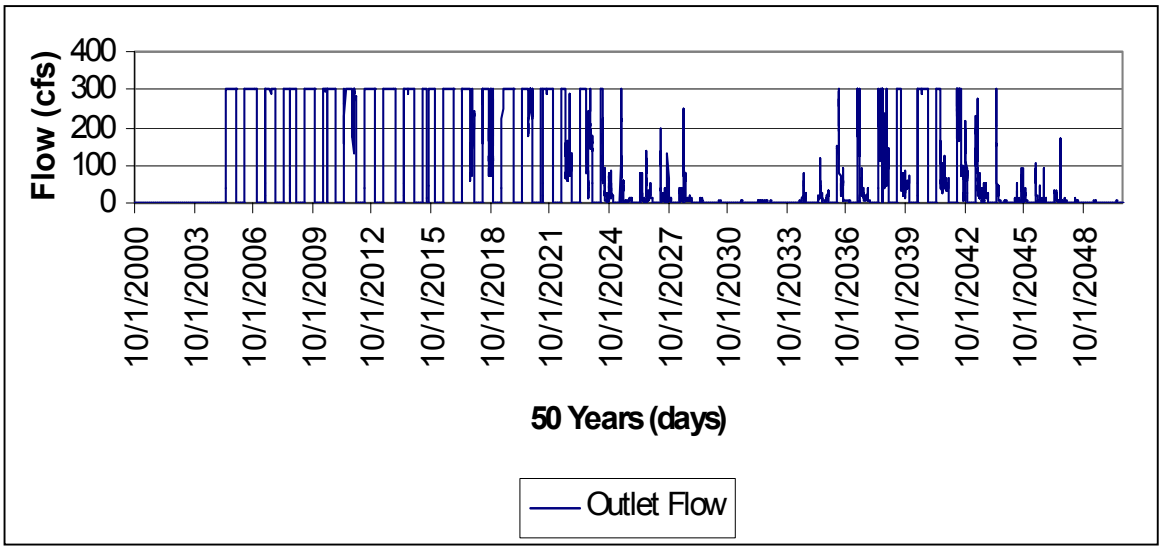

Figure 6-2: Devils Lake Outlet Flow

Figure 6-3 shows a typical operation year. The base flow shows a peak in the spring with lower flows in the summer, fall, and winter. The outlet flow begins on 1 May and flows at or very near capacity through most of the summer when the Pelican Lake water is fresh and flows in the Sheyenne River can be used for dilution. During the fall and winter, flows decline. Outlet operation ceases on 30 November.

Water Quality

The operation of an outlet would increase the level of constituents in the Sheyenne and Red Rivers. On the Sheyenne River, water quality standards are not exceeded but there are significant increases in, for example, TDS, sulfate, and chloride levels. Chloride concentrations would increase from 100 to 600 percent over the baseline on the Sheyenne River, but would still be below the 100 mg/l standard. The outlet would exceed standards for TDS on the Red River. Loading and concentrations for many constituents could exceed the 15-percent limit established for antidegradation by the State of North Dakota. Results from nutrient modeling indicate that nutrient loading could increase significantly. The changes in water quality constituents and nutrients would violate the State of North Dakota's antidegradation policy and the objectives under water quality promulgated by the International Joint Commission. See Chapter 4 of this report and Appendix A for more detailed information on water quality and nutrient modeling and results.

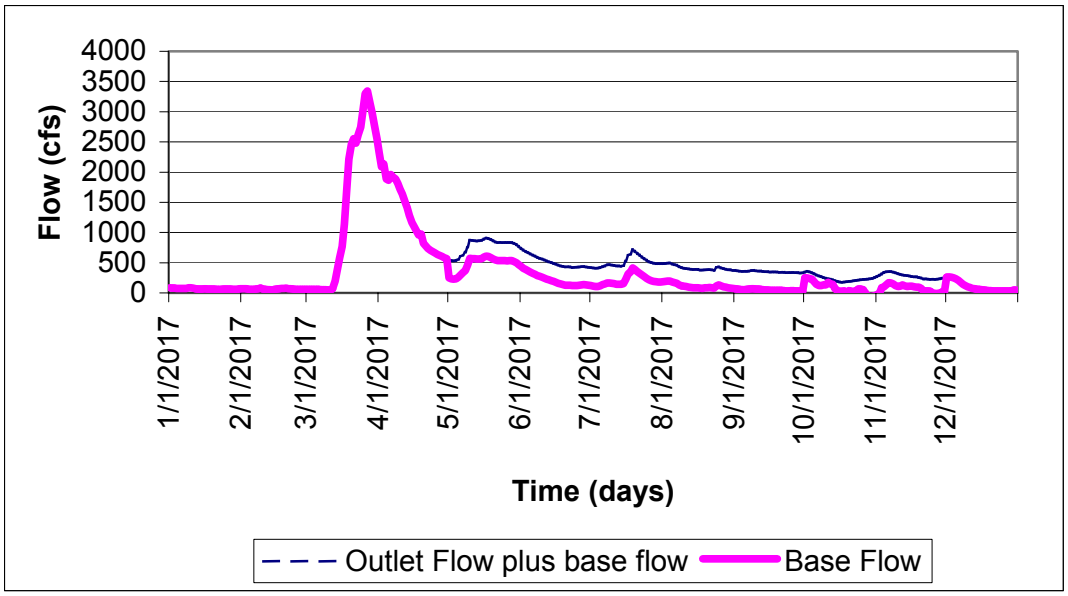

Figure 6-3: Outlet Flow at Cooperstown- Year 2017

Operation of a Pelican Lake outlet would affect both the water quality aspects and the physical characteristics of aquatic habitat on the Sheyenne River. While water quality constituents would not exceed tolerance levels for aquatic fauna in the Sheyenne or Red River, many constituent levels would be dramatically increased over baseline conditions. Water quality modeling indicates that the levels of these constituents would increase as much as 100 percent during pumping. Appendix A contains additional information on water quality for different lake levels and locations.

Geomorphology

Under the moderate climate pumping scenarios, top widths are expected to change only slightly from no pumping futures: up to 3 feet for the 300-cfs outlet alternative.

Adjustments in channel slope and channel bottom are also expected to be very minor. For the future outlet conditions, changes to channel meander length would be up to 30 feet different and up to 14 feet different for amplitude from the without-project conditions.

Studies have indicated that the operation of an outlet could result in changes in channel width, and in meander length and amplitude. Depending on location, channel widths on the Sheyenne River could change by as much as 3 feet on reaches below Baldhill Dam, to as much as 9 feet at some locations on the Sheyenne River above Baldhill Dam. Modeling results have indicated that there would be no change in stream meander length or amplitude over the base condition downstream of Lake Ashtabula. On the upper Sheyenne River, meander length could decrease in some reaches by as much as 44 feet, and meander amplitude by as much as 14 feet. Overall, this would represent less than a 5-percent change over the future without-project conditions.

The changes in flow duration, stage, and frequency would result in an increase in erosion and sedimentation on the Sheyenne River. For the natural resource analysis, it was assumed that erosion and deposition would be of equal magnitude. Modeling efforts, however, did not consider the potential change in erosion due to changes in vegetation characteristics along the banks of the Sheyenne River. It is probable that increased river stages during the growing season would result in the loss of vegetation along the lower portions of the bank. The potential weakening of the banks due to vegetative loss, along with increased shear stress and velocities along the bed and bank, would contribute to an increased erosion rate along the river. The effects may be more pronounced on the upper Sheyenne River because of the larger increase in river stage. Overall, it is likely that the net result of increased erosion on the upper Sheyenne River would be a slightly wider, shorter, and less sinuous river. See Appendices A and C for a summary of the geomorphological analysis.

Aquatic Resources

Changes in river stage and flow would also affect the amount and distribution of aquatic habitat types on the river. Limited modeling was done to evaluate potential changes in habitat availability that could occur with outlet operation. The six potential habitat types evaluated were: Shallow Pool – inhabited primarily by young of the year (YOY) and juvenile fishes; Medium Pool – used by a wide variety of species/life stages; Deep Pool – used primarily by generalist species; Slow Riffle – used by a wide variety of species/life stage and important as spawning habitat; Fast Riffle – used by few species but important because of its rarity on the Sheyenne River; and Raceway – dominated primarily by adult fish.

Modeling results indicate that on the upper Sheyenne River slow riffle habitat may decline, but the availability of other habitat types during the spring, summer, and fall may improve with higher flows. Downstream of Lake Ashtabula, shallow pool and medium pool habitats would generally decrease in availability over summer and fall, while slow riffle, fast riffle, deep pool, and raceway habitats would increase. Changes in habitat

composition and availability would result in changes in species composition and abundance. There may be some lost year classes of fish and declines in invertebrate populations. See Appendix C for a summary of the aquatic impact analysis and a more detailed discussion of effects of increased flow on habitat availability.

The changes on the Sheyenne River in water quality, hydrology, geomorphology, and habitat could result in substantial changes in or stress to aquatic biota. The changes above and below Lake Ashtabula would differ in magnitude and duration. On the upper Sheyenne River, increased habitat availability for some fish species may occur during outlet operation. The outlet operation would also cause the loss of spawning and nursery habitat, increased erosion, and changes in channel morphology. Increases in channel width may result in less available habitat once outlet operation ceases.

The Pelican Lake outlet would have an effect on water quality in the Sheyenne and Red Rivers. Even under a constrained operation approach, the levels of many water quality constituents are increased by two to three times to concentrations just below the established water quality standards.

The water quality charts in Appendix A show that although water quality standards on the Sheyenne River are not violated, the percent of time any particular concentration is exceeded increases dramatically. For example, sulfate exceedences increase from zero to 42 percent for the 250-mg/l sulfate level.

The river stage would also change with the operation of an outlet. The approximate changes to in-channel river stage are as follows: 2 feet at Sheyenne, 1.5 feet at Cooperstown and Valley City, and 1 foot at Lisbon and Kindred, and 0.5 feet or less at Oslo, Grand Forks, and at the international border. River stage affects the availability of aquatic habitat and would influence the amount of erosion and vegetation growing on the banks. On the Sheyenne River, depending on the location, the stage could increase 1.5 feet and the exceedence frequency could double. Stage increases are expected to be lower on the Red River and would remain in the channel.

The loss of habitat due to increased flows, changes in channel geometry, loss of overbank cover and sedimentation, coupled with changes in water quality and algal growth, would all contribute to a substantial change in the aquatic community present in the Sheyenne River. Projected water quality and quantity changes associated with outlet operation may adversely influence fish reproduction and result in lost-year classes. The threshold chloride levels for some aquatic species, such as mussels, would be approached with operation of an outlet; however, no direct effects due to increased chloride levels are anticipated. The cumulative result of all of these changes would be a decrease in diversity and density of aquatic species in the Sheyenne River.

Pumping would increase both summer and fall discharge, but winter discharge would decline to baseline levels. Average monthly flow decreases from more than 400 cfs in December to more than 75 cfs in January under pumping conditions compared to a decline of 170 cfs to 70 cfs under baseline conditions. With the increase in flow, some

change is expected in width and depth, and erosion would probably increase. Expected habitat changes include a decline of shallow pool, shallow riffle, and medium pool habitats and an increase in fast riffle, raceway, and deep pool habitats in spring, summer, and fall. Increases in summer and fall discharges reduce the slower flowing fish nursery habitat (slow riffle, shallow and medium pool guilds).

Monthly discharge would be highly altered during summer and fall, and then decline dramatically in winter. The timing and duration of annual extremes should not be affected. Habitat changes differ from upstream areas due to the difference in channel configuration. Shallow, medium, and deep pool habitats decrease in all seasons; whereas slow riffle, fast riffle, raceway, and deep/fast habitat increases. In the summer and fall, mean monthly discharge increases two- to fourfold over baseline conditions and habitat changes dramatically. The deep/fast habitat increases the most. Fish would be affected by the change to deep/fast less usable habitat in all seasons, and the loss of summer and fall habitat for shallow, medium, and deep pool guilds. Unionids and other invertebrates would be affected by the decrease in moderately flowing habitat. The increase in raceway and fast riffle habitat may benefit the tricopteran guild, but overall invertebrate diversity (low gradient guild) would be negatively affected. Macrophytes, although not common in this reach of the river, would probably be scoured by high flows. Unionids would most likely be affected by the dramatic decline between fall and winter flow. Many unionids would not survive these changes during outlet operation. Macrophyte habitat would be reduced by higher flows, and algae would be affected by water quality. Some invertebrate species would probably benefit from the newly created fast water habitats (tricopterans), but depositional species, which currently dominate the fauna, are likely to be negatively affected and overall invertebrate diversity (low gradient guild) will decline. Macrophytes will probably be scoured and prevented from recolonizing due to the increased flow and turbidity.

Effects in Lake Ashtabula include reduced retention time, increased nutrient loading, increased movement of fish out of the lake, increased salinity, and increased storage of water. The outlet would reduce the storage time in Lake Ashtabula and increase the turnover rate. This could affect walleye production and increased movement of some fish out of Lake Ashtabula and into downstream habitats. It is not expected that TDS would increase to a level that would affect reproduction or survival of aquatic species.

The operation of an outlet would affect river stages, groundwater levels near the river, erosion, availability of aquatic habitat, river access, and river crossing. The photos below (Figures 6-4 and 6-5) identify some concerns associated with the operation of an outlet.

In summary, changes in hydrology would be significant with a Pelican Lake alternative because large amounts of water could be discharged during wet periods in the Devils Lake basin due to improved water quality. Erosion will be greater, summer nursery habitat will be less, unproductive habitat will increase in summer and fall, and change in flow magnitude between fall and winter will be greater. Therefore, aquatic communities may survive the water quality changes of the alternative, only to be affected by the

Figure 6-4: Aquatic habitat sampling in reach J1 located on the upper Sheyenne River near the town of Sheyenne. In this area, the river stage would be increased up to 3 feet with the outlet resulting in some overbank flooding of low areas along the river. At lower stages, groundwater levels would be increased in the floodplain areas affecting vegetation density and composition and access to the river by landowners

Figure 6-5: Aquatic habitat sampling in reach B3 located downstream of Kindred. Note the vegetated banks stabilizing the channel. The outlet would result in increased stages of about 1 foot. Prolonged inundation would result in loss of vegetation, increased bank erosion, and sloughing

change in habitat and hydrology. The changes in the aquatic community would persist for many years after outlet operation has ceased.

After outlet operation ceases, slower flowing, shallow habitats would return and the upper reach would return to a less hydrologically stable condition. In addition, after a number of years of outlet operation the channel would have changed, probably becoming wider and deeper, such that the reduced water levels would result in less available wetted habitat (and higher temperatures) during low flow conditions. The increased flows associated with the operation of an outlet would also alter habitat distribution and probably result in some erosion and deposition. These changes would affect habitat conditions and availability when the outlet ceases operation. Only a few small permanent tributaries drain into the upper Sheyenne River, and their suitability as unionid refugia is not known. Fish hosts are prevented from carrying glochidia upstream past Baldhill Dam. Unless unionid refugia occur in the small tributaries, fauna is unlikely to recolonize to pre-project conditions. Fish species that benefited from the increased spawning and nursery habitat associated with higher flows would be negatively affected by the lack of these habitats with lower flow. Invertebrate fauna may recover over time. However, species composition would probably differ from pre-pumping conditions.

The change in nutrient concentrations and loading has been modeled. Results show that there would be little change in the concentrations of the various nutrients such as phosphorus, nitrates, nitrites, photoplankton, organics, and alkalinity, but there could be an increase in the total loading of nutrients with a Pelican Lake outlet. The model has shown that this increase in loading could occur to the international border on the Red River. Although there would be a projected increase in total loading, it is not expected to result in an increase in algal productivity on the Sheyenne River or on the main stem Red River. Factors other than nutrients appear to be controlling the amount of algal productivity. Algal productivity is not expected to increase in Lake Ashtabula, as productivity is already high. See the Water Quality Appendix A for additional information.

There is an increased risk of the transfer of biota or the increase in the distribution of existing organisms associated with any feature that improves the connectivity between systems that have been segregated for many centuries. The operation of the outlet would be considered such a feature. On the basis of the limited available information, there do not appear to be any organisms in Devils Lake that are not already present in the Red River of the North basin. However, it cannot be said with certainty that some may not be identified or introduced in the future. In addition, the operation of an outlet may improve the conditions necessary for the dispersal of organisms currently found in the Sheyenne or Red River. The sand filter would much reduce the possibility of biota transfer.

A pathogen study of selected fish in Devils Lake and the Sheyenne and Red Rivers revealed the presence of a bacterial agent that causes bacterial kidney disease in northern pike, walleye, and yellow perch. However, none of the fish had any external or internal clinical signs indicative of the disease. No viral or parasitic pathogens were found in the

sampled fish. (See Appendix C for more details regarding the methodology and findings of the fish screening analysis.)

Executive Order 13112 on Invasive Species directs Federal agencies to the extent practicable and permitted by law, and subject to availability of appropriations, and within administration budgetary limits to 1) prevent introduction of invasive species, 2) detect and respond to control invasive species populations, 3) monitor invasive species, 4) provide for restoration of native species, 5) conduct research, and 6) promote public education. In addition, the Federal agency should not authorize, fund, or carry out actions that it believes are likely to cause the introduction or spread of invasive species. Based on available information, Devils Lake does not contain any Minnesota or North Dakota listed exotic species. A sand filter is proposed to reduce the potential for the transfer of biota, and long-term monitoring would include surveys for biota of concern. Operation of an outlet may enhance conditions that could accelerate the spread of Eurasian watermilfoil, an invasive species that has been found at one location on the Sheyenne River. The Corps will recommend including provisions in the outlet operation plan to specify that, if long-term monitoring identifies that the operation results in the spread or introduction of invasive species, operation of the outlet will be suspended and immediate remedial actions will be initiated. Therefore, the study is considered to be in compliance with the Executive Order.

The following is a summary of some of the natural resource effects that could occur with the construction and operation of an outlet:

- Fish density/richness may increase in the upper Sheyenne River due to increased flow.
- Shallow pool habitat would decrease due to increased river stages.
- Erosion and sedimentation could reduce mussel populations.
- Reduced retention time in Lake Ashtabula could reduce walleye populations.
- Fish movement out of Lake Ashtabula would increase into downstream habitats.
- Non-productive habitat would increase downstream of Lake Ashtabula.
- Invertebrate density may decline, resulting in reduced fish density.
- Macrophyte abundance would be reduced.
- Aquatic biota may experience additional stress due to water quality changes.
- Fish, mussel, and macrophyte populations may decline.
- There would be little effect on Red River aquatic or terrestrial resources.
- Project design minimizes the potential for biota transfer
- Recovery could be slow due to lack of refuge habitat (i.e., tributaries).

See Appendix C for a more detailed discussion of aquatic resources impacts.

Terrestrial Resources

Vegetation in the riparian corridor may be affected by changes in groundwater elevation and quality, changes in frequency and duration of flooding, and induced erosion associated with increased flows. Based on the assumption of a ¼-mile area of influence,

groundwater changes could potentially affect about 112,000 acres of riparian lands along the Sheyenne River. Table 6-7 shows that most of the land use within ¼ mile is cropland or grassland. Depending on the current groundwater elevation, there could be a change in soil moisture and vegetative characteristics. This could occur in areas where the current groundwater level is near or within 3 feet of the surface. In rare instances, there could be overbank flooding due to unforecasted rainstorms and the inability to turn the outlet off in time. Table 6-7 below also identifies the land use within the currently identified flooded area outline.

Table 6-7: Land Use Along the Sheyenne River

Land Use	1/4 Mile Buffer (acres)			Flooded Area (acres)		
	Above Baldhill	Below Baldhill	Total	Above Baldhill	Below Baldhill	Total
Cropland	12,166	23,817	35,983	2,234	320	2,554
Woodland	7,181	13,125	20,306	1,273	199	1,472
Grassland	21,141	19,275	40,416	2,296	84	2,380
Grass-Shrub	1,613	2	1,615	89	0	89
Wetland	5,709	5,669	11,378	1,658	433	2,091
Urban	56	2,689	2,745	11	6	17
TOTAL	47,866	64,577	112,443	7,561	1,042	8,603

Source: 30-m Landsat Thematic Mapper 1987 through 1994.
Wetland information from the U.S. Fish and Wildlife Service National Wetlands Inventory (NWI).
Total wetland acreage includes 4,585 and 504 acres classified as river within the 1/4 mile buffer and flooded area outline, respectively.

Groundwater studies have been conducted along the lower Sheyenne River and in the area of the Sheyenne National Grasslands. On the basis of these studies, it is estimated that a 300-cfs flow event could result in an increase of up to about 1.5 feet in groundwater elevations near the river in the area of the Sheyenne Delta. At a distance of about 1,500 feet, the effect would be less than 4 in. No effect was predicted farther than 2,100 feet from the Sheyenne River. Other areas along the Sheyenne River are anticipated to experience smaller changes in groundwater levels, about a 0.5-foot raise out to 300 feet from the river. Groundwater studies were modeled with a controlled outlet flow. The magnitude and extent of the effects on groundwater would decrease as the flows declined over the duration of the operation. Using a ¼-mile area of influence, groundwater changes could potentially affect about 112,000 acres of riparian lands along the Sheyenne River and 76,000 acres along the Red River. However, the study showed that only two of the six transects in the Sheyenne Delta had a rise in groundwater levels of more than 0.5 foot farther than about 250 feet from the river. It is assumed that in areas where current groundwater levels are within 3 feet of the surface, a raise of 0.5 foot has the potential to affect the vegetation and land uses. For the purposes of this analysis,

it is assumed that the areas of potential groundwater influence are defined by the flooded area outline for a 1,000-cfs flow on the upper Sheyenne River and a 1,500-cfs flow on the lower Sheyenne River. It is assumed that the flooded areas are at lower elevations closer to the river, have current groundwater levels closer to the ground surface, and have the most potential for being affected by groundwater changes. This includes about 8,600 acres distributed as follows: 2,554 acres cropland, 1,472 acres woodland, 2,380 acres grassland, and 2,096 acres wetland. No groundwater effects are anticipated along the Red River due to the small change in river stages. The land use information identified for the flooded area outline is the area potentially affected by changed groundwater levels.

Upstream of Lake Ashtabula within the ¼-mile buffer along the river, which has been identified as the area of potential groundwater influence, there are about 370 landowners with an average land ownership of about 126 acres each. Downstream of Baldhill Dam there are about 850 landowners, each with about 75 acres within the ¼-mile buffer along the river. The increased flow in the river would have an effect on trail crossings and access across the river.

Within the flooded area outline and the area potentially most affected by changes in groundwater levels, there are about 300 landowners with an average of about 26 acres affected upstream of Lake Ashtabula and about 390 landowners with an average of about 3 acres affected downstream of Baldhill Dam. The increased groundwater levels would also make the soil surface wetter or softer, thereby affecting access to and across the river. Increased groundwater levels could also affect vegetative composition, soil salinity, and land uses.

Effects on the terrestrial communities would range from losses associated with erosion to changes in vegetation composition and density as a result of saturated soil conditions from elevated groundwater levels. The degree of change that may occur due to changes in soil conditions cannot be quantified at this time. However, it is likely that a large portion of the riparian vegetation would shift from woods to a more open community type, resulting in a concurrent change in animal species composition along the river. Changes in water quality to a more saline condition could also influence the amount and type of vegetation along the river. Some of the larger overstory forest trees may survive a year or longer but with reduced vigor. Once the outlet operation is completed, recovery of these areas through succession would occur, which could take decades in some areas.

The federally threatened western prairie fringed orchid is present in the area of the Sheyenne National Grasslands between Anselm and Kindred, North Dakota. The orchid is not found in the floodplain of the Sheyenne River, but in low-lying swales in upland areas more than 1 mile from the river. Therefore, it is not anticipated that the operation of an outlet would affect this species.

The States of North Dakota and Minnesota have developed lists of Natural Heritage sites that exhibit significant natural resource qualities. There are 213 Natural Heritage sites located within ¼ mile of the Sheyenne River area of potential groundwater influence.

This represents 25 percent of the Natural Heritage sites in the entire Sheyenne River basin. Within the flooded area outline along the Sheyenne River, there are 24 listed Natural Heritage sites. Natural Heritage sites could be affected by changes in flow, duration, storage, and water quality.

Natural Heritage sites are located in the Sheyenne River floodplain. These sites have the potential of being affected by changes in groundwater levels. Species composition and abundance could change due to changes in soil moisture and soil salinity.

Construction impacts along the outlet route are dependent on the project feature. Open channels have greater impacts than buried pipeline. There would be about 2 miles of excavation associated with the open channel along Highway 281; if any wetlands are drained, they would be restored following project operation. The buried pipeline would result in temporary impacts during construction. Disturbed areas would be revegetated and construction in wetlands would be done so as not to result in drainage or long-term impacts.

Red River Effects

The Red River is known for its recreational fishery, particularly for trophy catfish (Minnesota Department of Natural Resources and North Dakota Game and Fish Department, no date). Various agencies including the Minnesota Department of Natural Resources, the North Dakota Game and Fish Department, the Corps of Engineers, and local entities are modifying or replacing some of the low head dams on the river with raceways, and are trying to reestablish lake sturgeon in the river. This river also has water quality criteria within the United States of 500 mg/l TDS, 250 mg/l sulfate, 100 mg/l chloride, and at the Canadian border of 500 mg/l TDS, 250 mg/l sulfate, 100 mg/l chloride, 5.0 mg/l dissolved oxygen (DO), 200 per 100 ml of fecal coliform. Mercury accumulation is of particular concern, as methyl mercury levels in Red River fish are currently high and additional methyl mercury could be released in newly flooded areas. Background information on stream-bottom and fish-tissue mercury, other metals, and pesticides can be found in Brigham et al. (1998). Sediment transport into the Red River from the Sheyenne River with increased flows could also increase suspended sediment and sedimentation of riparian habitats (MNDNR, 1998).

Land use in the Red River basin within ¼ mile of the river is dominated by 62 percent agriculture. Woodland is second, with 19 percent of the area classified as wooded. Little effect to land use is expected along the Red River. The flows are expected to have little effect on river stage and to remain in the channel. Groundwater effects are anticipated to be minimal.

Operation of an outlet would result in some increases in the magnitude, frequency, and duration of elevated water quality constituents on the Red River. However, compared to the current water quality conditions in the river, these changes are not expected to be significant from an aquatic habitat standpoint. A major effect on the fishery of the Red River is not expected.

Along the Red River there are 82 listed Natural Heritage sites within ¼ mile of the river. These sites include aquatic and terrestrial wildlife species, vegetation types, and unique communities.

Soil Salinization Hazards

The water of the Devils Lake basin contains different levels of constituents than the Sheyenne and Red River basins. In addition, the soils along the Sheyenne River have naturally occurring levels of salts. As a result of these conditions, three salinization hazards are associated with a constructed outlet alternative:

(1) Induced floodplain salinization resulting from the raising of water tables of floodplain and adjacent soils in the Sheyenne River valley above a "critical depth."

(2) Additional salt loading to the floodplain could result from both overbank flooding with mixed Devils Lake/Sheyenne River water and intrusion of this water into adjacent floodplain soils as infiltrated floodwater and groundwater flow. Seepage outflow of mixed Devils Lake/Sheyenne River water could produce additional salt loading to adjacent floodplain soils during periods when the river is contained within the channel.

(3) Continued permitted use of mixed Devils Lake/Sheyenne River water to irrigate agricultural fields adjacent to the Sheyenne River and the Red River of the North.

Of 12,902 irrigated acres in the entire project area, 3,695 acres (29 percent) lie along the Sheyenne River. Both salinity and sodicity hazards were found to be substantially greater on the Sheyenne River than on the Red River. The outlet alternative would increase salinity hazards over baseline conditions on approximately 428 acres along the Sheyenne River.

Soil salinization hazards are also associated with the increased flow in the river due to the operation of an outlet. When compared to base conditions, the increase in sodium absorption rate (SAR) and TDS in Sheyenne River/Devils Lake blended water under the constructed outlet alternative is not, by itself, of sufficient magnitude to create significant soil salinization/sodification problems in soils to which it is intermittently applied.

A 300-cfs constrained outlet alternative would generally generate the lowest salinization hazard due to constraints on outlet operation. Under the 300-cfs constrained outlet alternative, the highest potential salinity hazards would exist in the shallowly entrenched till plain reach of the Sheyenne River compared to the more deeply entrenched reaches below Baldhill Dam. Problems would not necessarily be limited to the poorly and very poorly drained soils. Moderately well-drained soils that are in low positions may also have increased salinization hazards in response to raised water tables and more frequent flooding with blended water.

Poorly and very poorly drained soils that are susceptible to salinization are largely confined to abandoned meanders and channeled areas. These soils may be affected by

increased mean water tables and possible groundwater intrusion from the Sheyenne River during outlet operation.

Moderately well-drained soils that occupy levees and low rises on the floodplain were given a Slight-to-Moderate hazard due to the potential for additional salt loading from flooding and water table rise. Salinization hazards are less than the Moderate-to-Severe category because of less frequent flooding, little or no groundwater intrusion, and deeper seasonal high water tables. Just under 8,000 acres of primarily fine and medium textured, moderately well-drained floodplain soils were placed in the Slight-to-Moderate salinization categories. LaDelle soils may be the most affected because of potential high levels of subsoil salinity, occasional flooding, and seasonal high water tables within 3 to 4 feet of the soil surface.

Salinization hazards in the Upstream Associations result from; (1) the shallow entrenchment of the Sheyenne River, and (2) the presence of extensive areas of poorly and very poorly drained, fine-textured, slowly permeable soils that are already saline or have substantial, readily mobilized subsoil salinity. Based on groundwater modeling, there are about 2,000 acres of agricultural land that could be affected by raised groundwater levels. Some of this area may be susceptible to increased soil salinity.

Biota Transfer Risk

The potential for an outlet to transfer biota from Devils Lake to the Red River basin was evaluated. This assessment was based primarily on existing information.

The conclusions of the study were that: (1) on the basis of all available information, it appears highly unlikely that downstream habitats would suffer substantially as a result of biota transfer caused by the Devils Lake outlet project, and (2) available information is inadequate to allow conclusive statements to be made regarding all aspects of biota transfer.

However, there are concerns worth noting:

A. The risk of striped bass transfer to downstream waters is considered very low, primarily because the species is not believed to be reproducing in Devils Lake. This belief should be confirmed or refuted with larval and juvenile fish surveys.

B. The outlet would only marginally increase the risk of downstream spread of Eurasian watermilfoil, which is highly likely to occur with or without an outlet.

C. Though unlikely to occur, transfer of significant concentrations of toxic algae could cause substantial problems downstream.

D. Salinity and nutrient changes to the Sheyenne River and Lake Ashtabula could cause community composition changes in these waters.

E. It is unknown whether any exotic, invasive species are now present in Devils Lake.

Table 6-8 summarizes the biota transfer analysis. The Probable Biota of Concern (PBOC) are defined as biota that could directly or indirectly cause environmental and economic damage in the Red River Basin (including North Dakota, Minnesota, and Canada). The Candidate PBOC list included 527 algae, 353 plant species, 94 free-living protozoa taxa, 146 invertebrate taxa, 12 fishes, 8 fish parasites, and 1 avian pathogen (no fish pathogens or fungi were included). Once the PBOC list was compiled, it was necessary to determine which of these species should be carried forward into a full risk assessment process. Biota for Risk Assessment (BRA) were identified by the species invasiveness, its likely effects on downstream communities, the likelihood of the species spreading further downstream, and the likelihood of economic costs associated with the species. Two species were retained for full risk analysis: striped bass and Eurasian watermilfoil.

All of the species recorded in Devils Lake were either known or considered likely to be present in the Red River basin. The one possible exception is the striped bass, which has not been recorded in the lake in many years. Many species have not been reported in the Red River basin but were found to have sufficient means of overland or airborne dispersal, such that the proposed outlet would have little, if any, impact on their presence or invasiveness in the Red River basin. Other species not initially known to be in the Red River basin were subsequently confirmed as being there on the basis of published scientific literature or from unpublished information provided by experts contacted for this study. However, experts have indicated that the one possible exception, striped bass, has not become established as a reproducing population in Devils Lake, and no further stocking is planned. If any of the originally stocked individuals remain in the lake, they would now be large and would easily be excluded from outlet pipelines and machinery by fish screens already planned to cover the intake openings.

Eurasian watermilfoil is not reported in Devils Lake but is found in limited areas in the Red River basin. The operation of an outlet could enhance the distribution of milfoil by uprooting and transporting plant fragments to other locations. However, it is expected that milfoil would probably expand its present distribution under natural conditions. The outlet could speed up this process.

The literature review has identified that there are substantial data gaps in the knowledge of biota in both the Devils Lake and Red River basins and that further field investigations would be necessary to render a definitive analysis of presence/absence of biota of concern. The increased use of Devils Lake for recreational purposes, combined with the natural dispersal mechanisms of invasive species, results in an extremely high risk that biota of concern could already be present or have a high risk of being introduced into the Devils Lake watershed at any time in the future. If biota of concern are present or invade Devils Lake, the risk is also extremely high that these biota would be transferred via a pumping operation from Devils Lake into the Sheyenne River if a preventative filtering system were not in place. A sand filter (effective filter size 2 microns) is incorporated as a project feature and would minimize the potential that outlet operation would result in the transfer of biota from Devils Lake to the Sheyenne River.

Table 6-8. Summarized Project Results: Screening of All Devils Lake Taxa and Automatically Listed Taxa (ALT) from Candidate PBOC Through BRA Stages, with Recommendations for Further Action

BIOTA GROUP	# of Candidate PBOC Taxa	# of 1st-Round Deselections	1st Round Deselection Reasons[1]	# of PBOC (w/ALT)	# of 2nd-Round Deselections	2nd Round Deselection Reasons	Results: Further Analysis of Remaining Species	# of BRA taxa	Recommendations
Algae	526	310	All deselected taxa: A	**216 (0)**	212	B, D (& probably A)	4 species: hazard probability very low	**0**	Monitor concentrations of nutrients, salts, and toxic Cyanobacteria in outlet
Vascular Plants	368	353	All deselected taxa: A	**15 (15)**	15	4 ALT: A 11 ALT: C	None	**0**	Consider monitoring for "reverse" transfers FROM Red River basin TO Devils Lake
Protozoa	94	0	n.a.	**94 (0)**	94	B, D (& probably A)	None	**0**	None
Invertebrates	161	88	All 52 insect & mite taxa: B 36 other taxa: A	**69 (4)**	69	4 ALT: C All others: B, D (& probably A)	None, but see Recommendations	**0**	Initial survey, future monitoring for zebra mussel, rusty crayfish, spiny water flea in Devils Lake
Fishes	27	11	All deselected taxa: A	**16 (16)**	14	C	None, but see Recommendations	**0**	Future monitoring for zander, grass carp in Devils Lake
Fish Parasites	8	5	All deselected taxa: A	**3 (0)**	0	n.a.	3 species: already found in Red River basin	**0**	Find Acanthocephalan worms in Devils Lake fishes and obtain authoritative identification
Fish Pathogens	7	0	n.a.	**7 (7)**	7	C	n.a.	**0**	Screen Devils Lake basin fishes for pathogens
Other Pathogens	1	0	n.a.	**1 (0)**	1	B	n.a.	**0**	None

[1] Deselection Codes: A - Known/believed to be already present in Red River basin.
B - Existing interbasin transfer pathways believed to be very effective.
C - Not known to exist in Devils Lake basin.
D - Not known to cause problems; believed to be benign.

Threatened and Endangered Species

Federally listed species in the study area include the bald eagle, whooping crane, gray wolf, western prairie fringed orchid, and piping plover. A biological assessment has been prepared addressing the potential effects of an outlet on these species. The Corps of Engineers determined that there would be no effects to any federally listed species, and the U.S. Fish and Wildlife Service agreed with that conclusion.

SUMMARY: A brief summary of the potential natural resource effects associated with a 300-cfs outlet from Pelican Lake follows.

Water Quality: Water quality standards would not be violated on the Sheyenne River, but would be degraded significantly. Sulfate constituent exceedences over 250 mg/l would increase from 0 to 42 percent under the moderate 1455 lake level scenario. Nutrient loading would also increase significantly. Phosphorus loading could increase on the Red and Sheyenne Rivers. This degradation of water quality could affect beneficial uses of the rivers.

Geomorphology: The channel morphology will change as a result of outlet operation. Channel meander length, amplitude, and width will increase over the without-project conditions.

Flow Regime: Discharges of up to 300 cfs from May through November for as long as required would represent a five- to tenfold increase in summer/fall flows along the Sheyenne River. The length of operation depends on the future climatic conditions, but an outlet could be operated for many years.

Erosion: The addition of 300 cfs in the river would produce a mean channel velocity with levels less than 1.5 fps. Due to low mean channel velocity, it is unlikely that noticeable erosion would occur during the months that pumping would be employed. However, the increased discharge would raise water surface elevations by up to 3 feet. This long-term stage increase would kill existing vegetation in this zone. After several years, the loss of vegetation would likely increase the potential for erosion of the banks during high flow periods.

Groundwater: The stage increase associated with a 300-cfs discharge would be similar to the stage increase observed in the groundwater studies. On the basis of the studies, it is estimated that operation of the outlet could result in an increase of up to about 1.5 feet in groundwater elevations near the river in the area of the Sheyenne Delta. At a distance of about 1,500 feet, the effect would be less than 4 inches. No effect was predicted farther than 2,100 feet from the Sheyenne River. Other areas along the Sheyenne River are anticipated to experience increases in groundwater levels on the order of about 0.5 foot out to a distance of about 300 feet. This could potentially affect about 112,000 acres of riparian lands along the Sheyenne River. Using the area potentially affected by a 0.5-foot change in groundwater levels, about 8,600 acres could be affected. There would likely be no change in groundwater elevations along the Red River.

Terrestrial Communities: There would likely be no immediate changes to the terrestrial communities along the Sheyenne or Red River. However, long-term operation of an outlet (more than 5 years) could result in subtle changes in vegetation composition and density due to elevated groundwater levels. Changes in wildlife species composition and distribution along the Sheyenne River could be the result of these long-term shifts in vegetation composition.

Aquatic Communities: Although water quality changes would be associated with the operation of an emergency outlet, sulfate levels would generally be below established standards. The most flow-sensitive habitat types, such as riffles, where shallow, fast habitats predominate, would be substantially reduced under a 300-cfs discharge alternative. The loss of these habitat types would adversely affect species life stages, which are dependent on shallow, fast water for spawning, feeding, or other life requisites provided by riffles. Other habitat types such as shallow, slow habitat would also be reduced.

Physical changes in channel geometry would occur under the 300-cfs outlet alternative; adjustments in channel geometry would occur as the river attempts to restore a more natural hydrograph. Adverse impacts on aquatic habitats would be a result of these adjustments.

The effect of all these chronic changes in water quality, flow, and channel geometry would likely be a reduction in the diversity and abundance of aquatic species in the Sheyenne River. Species more tolerant of wider fluctuations in water quality and flow would eventually dominate the system. As with other flow events, reestablishment of existing species composition could take decades after the operation of the outlet has ceased.

Soil Salinity: The outlet would result in an increase in salinity hazards associated with use of the water for irrigation purposes. Inundation of soils with outlet water would have little or no effect on soil salinity and did not result in any reclassification of soils due to salinity. Increases in groundwater levels due to increased river stages could result in the movement of salts currently found in soils into the rooting zone of vegetation. This could affect species composition and use of those soils.

Biota Transfer: There is a potential for the introduction of new species into Devils Lake due to recreation and the creation of new habitats. The sand filter would minimize the potential that outlet operation would result in the transfer of biota from Devils Lake to the Sheyenne River.

Threatened and Endangered Species: No effect.

Downstream Water Users: Downstream water users would experience adverse effects from the operation of an outlet requiring modification to their water supply systems and/or changes in land use practices. It is not anticipated that changes in water quality constituents would affect the operation of the National Fish Hatchery. Higher river stage could affect the ability to drain the rearing ponds at the hatchery.

Cultural Resources

The Pelican Lake outlet has yet to be surveyed for cultural resources. Cultural resources sites along the outlet alignment would be affected by construction. A pipeline outlet would affect a narrower corridor than an open channel outlet. A known site at the

confluence of Peterson Coulee with the Sheyenne River needs evaluation of its National Register eligibility and may need mitigation excavation prior to construction. A pipeline alternative is easier to route around any significant cultural resources than an open channel, thereby reducing the potential for effects to resources. Increased quantity and duration of high water in the Sheyenne River would cause increased erosion of cultural resources sites along its banks over what occurs naturally. Mitigation of impacts to cultural resources sites along the Sheyenne River will be necessary.

Other States, Nations, and Tribal Resources

The outlet would pass through portions of the Fort Totten Indian Reservation and would affect Tribal resources around Devils Lake and downstream along the Sheyenne River. These impacts are similar to those described above for erosion, vegetation, aquatic resources, water users, groundwater, soil salinity, and wildlife.

An outlet has been coordinated for compliance with Environmental Justice in accordance with Corps policy. As described above, an outlet is expected to have minimal adverse effects on the Reservation. At various times, the Tribe has opposed an outlet from Devils Lake or the west end of the lake.

Minnesota and Canada have also expressed opposition to an outlet for water quality and biota transfer reasons. The outlet has to be coordinated for compliance with the Boundary Waters Treaty of 1909. The outlet does not comply with antidegradation policies promulgated under the treaty.

An analysis of trans-boundary effects of a Devils Lake outlet was based on the effects observed at the border. It is anticipated that there would be little effect on water quality, flow, erosion, or groundwater levels along the Red River. It was also determined that there would be little risk of new biota being introduced to downstream areas due to an outlet. Therefore, it was concluded that an outlet would have little effect on natural resources along the Red River. This determination was extended into Canada. One area that has the potential for impacts in Canada and Lake Winnipeg is nutrient loading.

The operation of an outlet would degrade water quality on the Red River. The changes in nutrient loading and water quality constituents would be contrary to current initiatives in Canada to reduce phosphorus loading to Lake Winnipeg. Coordination with Canada for compliance with the Boundary Waters Treaty has not been completed at this time. Section 207 of Public Law 107-206 authorized the Corps to provide funds to the United States Section of the IJC for the purpose of conducting investigations, undertaking studies, and preparing reports in connection with a Reference to the IJC under Article IX of the Boundary Waters Treaty for an emergency outlet for Devils Lake, North Dakota. Pursuant to that authority, the Corps transferred funds in the amount of $500,000 to the IJC's U.S. Section in September 2002.

Although the Devils Lake outlet would have minimal impacts on the fishery in the Red River (and Lake Winnipeg) in Manitoba, it is important to recognize the significance of the fishery to First Nation communities. There are three statutory divisions of angling in Manitoba: domestic, commercial, and recreational. Domestic and commercial fishing are discussed below with respect to their significance for First Nation communities.

Domestic fishing (i.e., fishing for food) is a traditional and continuing source of food for First Nation communities. Fishing also plays an important role in bringing people together socially, including the celebration of religious and cultural traditions.

Treaties were signed in the late 1800s and early 1900s between Canada and the First Nations. These treaties protected the right of Status Indians to fish for food during any time of the year. In 1990, the Supreme Court of Canada issued a landmark ruling in the *Sparrow* decision. This decision defined Aboriginal peoples' right to fish for food, social, and ceremonial purposes. This right takes priority over all other uses of the fishery, subject to certain overriding considerations such as conservation of the resource. The Supreme Court also necessitated consultations with Aboriginal groups when their fishing rights might be affected.

In Manitoba, domestic fishing by First Nation peoples is given the highest priority for harvest of the fishery resource. Historically, the provincial government of Manitoba interpreted permitting requirements for domestic fisheries to be an infringement of the fishing rights of First Nation peoples, unless there was an overriding fishery conservation issue affecting resource sustainability. There remains no current permitting requirement for domestic fishing. Consequently, Manitoba Conservation, Fisheries Division, has very little data regarding the size, composition, and economic value of the annual domestic fishery harvest.

Over 23,000 permanent residents living in 30 communities along the shore of Lake Winnipeg depend upon the lake's fishery as a food source. The majority of these residents are Aboriginal, with over 9,000 being First Nations. The most active First Nation peoples fishing Lake Winnipeg are: Grand Rapids (November 2001 registered population 1,250), Fisher River (2,932), Poplar River First Nation (1,161), Berens River (2,279), Hollow Water (1,289), Dauphin River (242), Lake St. Martin (1,847), and Norway House Cree Nation (1996 population – 3,402), (Swanson, 2001 and Statistics Canada).

Manitoba's commercial fishery produces 33 percent of the total value of Canada's freshwater commercial harvest. Commercial fishing affects the local economies of many small communities and the industry employs approximately 3,200 people in the province. Since 1986, the annual commercial harvest has averaged about 26.6 million pounds per year. This represents nearly $15.3 million (US) a year that is invested back into Manitoba's economy. Whitefish (23 percent), mullet (23 percent), pickerel (20 percent), northern pike (11 percent), and sauger (10 percent) are the major species commercially harvested in Manitoba. Of these species, pickerel accounts for 47 percent of the landed value paid directly to commercial fishermen, due to its high market price. Sauger and whitefish represent 20 percent and 14 percent of the landed value, respectively.

The Lake Winnipeg fishery accounts for approximately 50 percent of the total commercial fish harvest from Manitoba. Each year, approximately 800 licensed commercial fishers operate on Lake Winnipeg, catching a variety of species, including pickerel, goldeye, sauger, and whitefish. Commercial fishers also directly employ another 150 persons to assist with fishing operations. The annual direct value of the landed catch is approximately $9.4 million (US). For many involved in the commercial fishing sector, this is their only source of income. Harvests of walleye and sauger on Lake Winnipeg are declining, but not due to a lack of effort by fishermen. The declines follow periods of high production, indicating that stocks are being exploited at, or beyond, sustainable harvest levels. Quotas have been redefined to better reflect sustainable harvest levels for these fish. The walleye and sauger harvest has been capped at 20 percent of existing quotas. In addition, season openings have been set by lake area to follow completion of walleye spawning. Also, the Lake Manitoba small mesh fishery for perch is reviewed annually to determine its impacts on walleye and sauger stocks. The total direct and indirect annual value of the Lake Winnipeg and Red River commercial and sport fishery to the Manitoba economy is approximately $31 million (US).

Mitigation

Construction and operation of an outlet from Devils Lake includes a mitigation plan to compensate for unavoidable adverse effects. General geographic areas of potential impact would be Devils Lake, the outlet route, the Sheyenne River, Lake Ashtabula, and the Red River. Investigations to date indicate the greatest potential for significant adverse impacts to natural resources, cultural resources, and downstream water users is associated primarily with increased flows and water quality changes on the Sheyenne River. It appears that impacts in and around Devils Lake or along the Red River are of minor magnitude or probability of occurrence, when compared to impacts along the Sheyenne River, as to constitute only a minor percentage of overall mitigation costs. A preliminary estimate for mitigating losses to natural and cultural resources is summarized below. The following assumptions were made in developing this proposal:

- The outlet design would be primarily a buried pipeline from Pelican Lake along Peterson Coulee to the Sheyenne River. Open channel construction would be restricted to areas along Highway 281. The Dry Lake diversion would result in minimal effects to natural resources.

- Operation of the outlet would not result in a change in the operation plan of Baldhill Dam. Baldhill Dam will operate within its present authority and would result in more frequent and longer duration of storage in the flood pool.

- The primary downstream area affected would be those areas flooded when the flow on the upper and lower Sheyenne River reaches 1,000 and 1,500 cfs, respectively.

- Operation of an outlet at 300 cfs would have limited effect on the extent or duration of flooded area along the upper or lower Sheyenne River with flows not exceeding 1,000 or 1,500 cfs, respectively.

- Operation of a 300-cfs outlet would have negligible effects on out-of-bank flows or erosion on the Red River.

- The operation of an outlet would have limited effects on the aquatic habitat in Devils Lake.

The outlet itself would consist primarily of a buried pipeline with open channel features restricted to about 2 miles along Highway 281 north of Minnewaukan and would not require specific mitigation. If drainage of wetlands occurs in this area the channel would be restored to pre-project conditions following operation of the outlet. The pipeline route would affect upland areas and wetlands. Vegetation effects would be minimized to the extent practical. There would be temporary impacts during construction, but long-term impacts should be minimal, requiring little, if any, mitigation.

Because of the inability to accurately quantify all of the project impacts associated with operation, mitigation measures are included to alleviate effects and try to maintain some existing critical aquatic habitats to facilitate recovery following project operation. An adaptive mitigation approach is also recommended. This approach would include monitoring to assess the effectiveness of mitigation measures and to identify if modification to the mitigation measures is needed. Coordination with Federal, State, and local agencies and interest groups will be required to implement the monitoring and mitigation program. Areas that would require monitoring include, but may not be limited to: groundwater, erosion, sedimentation, aquatic habitat, biota transfer, water quality, riparian vegetation, cultural resources, soil salinity, downstream water users, and endangered species. Monitoring is a major component of the proposed mitigation package. A major purpose of monitoring is to conduct follow-up surveys of the resources during project operation. Monitoring is needed to assess the effects of the operation of an outlet. Monitoring would be used to modify mitigation during and after project operation as determined necessary. A framework for the mitigation monitoring approach has been developed (see Appendix C). An interagency task force would have to be established to manage and coordinate the long-term monitoring program. Monitoring would require a long-term commitment of time and funds by agencies involved in the operation of an outlet. It is assumed that monitoring would be required for the life of the project or until agency coordination determines it is no longer necessary.

The purpose of the mitigation and monitoring features is to alleviate the effects caused by the construction and operation of an outlet. Figure 6-6 shows the locations of potential mitigation and monitoring sites. These sites are subject to change following more detailed analysis and field verification.

Figure 6-6. Potential Locations for Mitigation and Monitoring Sites (see Appendix C for individual sheets showing locations)

SUMMARY OF IMPACTS / MITIGATION / MONITORING

IMPACTS

Construction Impacts

Dry Lake Diversion

- Temporary water quality effects in Dry Lake and chain of lakes during construction.
- Construction of project features may affect some wetland or grassland areas.

Pelican Lake to Peterson Coulee

- Lake Dredging may affect some wetland areas currently inundated by Devils Lake.
- Temporary impact to wetlands along alignment as pipeline is buried.
- 3 acres of wetlands and about 81 acres of grassland/grazing land affected by the construction of the 84-acre regulation reservoir.

Peterson Coulee to Sheyenne River

- Temporary impacts to unavoidable wetland areas along alignment as pipeline is buried.

Operation Impacts

Dry Lake Diversion

- Will affect flows and lake elevation in the chain of lakes (Chain Lake, Mike's Lake, Lake Alice, and Lake Irving).
- May affect operation and management on Lake Alice National Wildlife Refuge and other lands administered by the U.S. Fish and Wildlife Service.
- Fluctuating water levels will affect 28,600 acres around the chain of lakes.

Sheyenne and Red Rivers

Water Quality

- Degradation of water quality on the Sheyenne River due to increase in TDS and constituent levels.
- Increased turbidity and sedimentation.
- Increased mercury methylation.

Groundwater

- Increased groundwater elevations along Sheyenne River.

Soil Salinity

- Increased groundwater could increase soil salinity on approximately 6,300 acres along the Sheyenne River. Such changes may affect the use or condition of soils.

- Increased salinity hazard classification on approximately 430 irrigated acres along the Sheyenne River.

Erosion/Sedimentation
- Increased erosion along Sheyenne River – Wet scenario modeling shows an increase of 85 acres over the without pumping condition.
- Loss of bank vegetation not considered in modeling and could significantly increase amount of erosion.
- Increased sedimentation – not quantified or modeled.

Aquatic Habitat
- Some shifts in the availability and amount of habitat types due to changed flows along Sheyenne River.
- Potential increases in erosion, changes in sedimentation patterns, bank vegetation, substrate and flow patterns could all affect unquantified changes in habitat availability and quality.

Aquatic Ecosystem
- Increases in TDS, nutrients, and turbidity and changes in sediment deposition, flow rates, river stages, and habitat availability/quantity/quality will likely have affects on abundance of fish, mussels, macroinvertebrates, algae, and macrophytes along the Sheyenne River.
- Likely changes would be shifts in species composition and abundance.
- Current data do not indicate that any species would be extirpated and recovery is anticipated after operation of the outlet ceases.

Riparian Vegetation Impacts
- Increased groundwater elevations may affect approximately 6,032 acres of woodland (1,472 acres), grassland (2,469 acres), and wetland (2,092 acres) along the Sheyenne River (5,316 upstream of Lake Ashtabula and 716 acres downstream of Lake Ashtabula).
- Changes in vegetation community composition, affecting existing habitat suitability and habitat quality (not quantified) could occur.

Biota Transfer
- Based on existing information, highly unlikely that outlet operation would transfer species currently not already in the Red River Drainage Basin from Devils Lake to the Sheyenne River.
- Outlet operation could increase the rate of spread of invasive species (such as Eurasian watermilfoil) already documented to occur on the Sheyenne River.
- Outlet operation would facilitate transfer of any species that may become established in Devils Lake.

Cultural Resources
- Approximately 53 known sites would be affected by increased or accelerated erosion.
- Other currently unknown sites could be affected by erosion or flooding.

Surface Water Users
- 8 Municipal Water Treatment Facilities, 2 industrial, and 201 individual permitted users (irrigation, livestock, domestic and other) – increased treatment costs (probably for hardness) or change in suitability for use.
- Unknown number of un-permitted users affected (domestic, livestock, lawns and gardens, vegetable crops, trees and shrubs, recreational) - possible change in suitability for use.

Valley City National Fish Hatchery
- Increased flows may affect ability to drain rearing ponds.
- Increased TDS levels may have limited effects on fish rearing at Valley City.
- Elevated TDS could accelerate corrosion of iron pipes at the hatcheries.

MITIGATION

For Construction Impacts

Avoid/Minimize
- Best Management practices to minimize water quality impacts and erosion during construction. This is standard operating procedure and a condition of many permits.
- Adjust pipeline alignment during construction to avoid construction in wetlands to extent practicable.
- Buried pipeline avoids potential induced drainage effects to wetlands adjacent to alignment and minimizes effects where alignment intersects wetlands.
- Buried pipeline avoids long-term impacts to land owners along alignment.
- Restore wetland areas to pre-project conditions after outlet ceases operation to maintain original hydrology in important wetland areas.

For Operation Impacts

Avoid/Minimize
- Drawing water from Pelican Lake minimizes effects to the extent practicable. The freshest possible water would be withdrawn from Devils Lake. This minimizes downstream water quality effects on aquatic organisms.
- 300-mg/l water quality constraint and 600-cfs channel capacity constraint minimize impacts on Sheyenne River and Red River related to water quality and flooding to the extent practicable. This minimizes, to the extent practical, effects to downstream aquatic resources, groundwater, riparian resources, and water users.

- Erosion protection of 23 critical sites and acquisition of 133 acres immediately downstream of insertion point reduces effects of induced sedimentation on aquatic habitat due to erosion. This would minimize the amount of turbidity and sedimentation at any one site and its associated effects on aquatic organisms (see Figure 6-7 for currently identified erosion protection sites). Monitoring may identify other sites that may need protection in the future.
- Erosion protection of 53 known cultural sites along the Sheyenne River avoids loss of sites through accelerated erosion (see Figure 6-7 for locations). Monitoring may identify additional sites that may need protection, evaluation, or data recovery in the future.
- Ramping flows during operation to minimize flow effects on aquatic resources. Flow ramping would help allow organisms to move as river levels recede. Flows would be ramped at the initiation and cessation of the yearly operation and, to the extent possible, during the year when releases are changed significantly. This would minimize stranding effects and help maintain the existing aquatic resources and aid future recovery.
- Installation of a sand filter to minimize, to the extent practicable, transfer of biota from Devils Lake. The sand filter would, to the extent practical, prevent fish, plants, invertebrates, algae, and other organisms leaving Devils Lake via the outlet. It would also help reduce downstream nutrient loading. Sand filter would require cleaning and disposal of filtered material.
- Extensive Monitoring and Rapid Response protocol for biota of concern. Periodic monitoring would be needed in Devils Lake, the regulation reservoir, and the Red River basin to determine if species are introduced or are expanding. The potential framework developed for rapid response plans consisting of eradication, monitoring, or ceasing outlet operation would allow time for the operating committee to further develop an acceptable response to invasive species. Some vegetative species could be eradicated when identified depending on the extent of the infestation. Aquatic species may require extensive monitoring or stoppage of outlet operation until the operating committee can identify an acceptable response procedure.
- Long-term monitoring of resources. Mitigation features and various resources (water quality, water users, erosion, soil salinity, groundwater, cultural resources, aquatic resources, and terrestrial resources) would be monitored to determine effectiveness of the mitigation features and possible need for additional mitigation. A monitoring framework is identified in Appendix C and consists of the establishment and periodic monitoring of resources.
- Operate gates at Baldhill Dam to facilitate drainage of hatchery rearing ponds during high flow. Reducing the outflow from Baldhill Dam for a few days would allow the river stage to recede and the rearing ponds to be drawn down.
- Riprap at low-head dams for safety concerns. Erosion protection downstream of 10 dams on the Sheyenne River for safety reasons due to higher flows. Riprap and the flattening of the slope would decrease the roller effect caused by the higher flows.

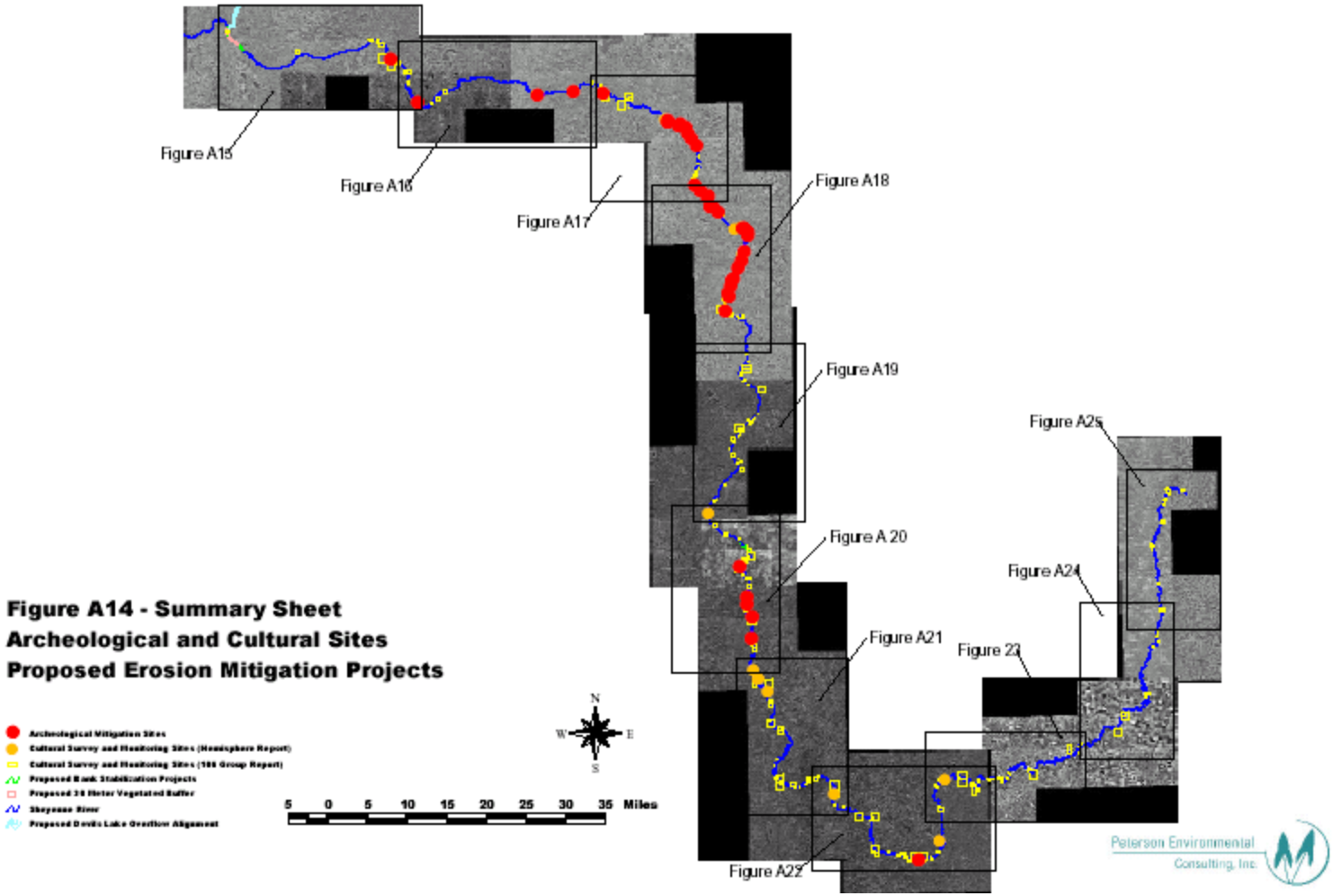

Figure 6-7. Overview of cultural and erosion protection sites

- Increased collection/analysis of fish on the Sheyenne River for mercury and modification of consumption advisories if warranted. The State currently collects and analyzes fish for mercury.
- The U.S. Fish and Wildlife Service is anticipating replacement of the pipes at the hatchery facilities with non-corrosive materials as part of their normal maintenance activities.

Compensate

- Acquisition and management of approximately 6,032 acres of riparian habitat (see Figure 6-6 and Appendix C for locations of potential mitigation areas and monitoring locations). The acquisition and management of riparian lands along the Sheyenne River is to mitigate for the groundwater effects associated with the operation of an outlet. These lands would be located in high quality habitats including lands affected by the project and adjacent lands. Vegetation plantings, fencing, and other management activities are included. The purpose is to preserve and enhance some habitat and help the recovery and restoration of the riparian corridor.
- Construction of nine high-flow bypass channels for aquatic mitigation (see Figure 6-6 and Appendix C for location information and an example site). This would consist of the excavation of bypass channels, placement of control structures or pipes, and erosion protection as necessary. The purpose of these areas is to preserve some critical areas that can serve as refugia to help facilitate the recovery of the aquatic environment after operation of the outlet. These features would also preserve some existing habitat during project operation. About 26,000 feet of bypass channel would be constructed to maintain about 94,000 feet of existing river channel.
- Reimbursement for increased treatment costs for municipal and industrial water users. The mitigation would consist of compensation to users for additional treatment for hardness.
- Monitoring and compensation for effects on soil salinity. Lands potentially affected by increased groundwater and soil salinity would be monitored. Increased soil salinity may require compensation to landowners' for economic effects on agricultural uses.
- Acquisition of easements for induced damages due to flooding and increased groundwater elevations. Real estate easements would be acquired for effects to agricultural users.

Monitoring

The current mitigation proposal acknowledges potential effects on aquatic and riparian resources but assumes that if the ecological integrity of the Sheyenne River and the riparian corridor is maintained, the river's natural state will recover upon cessation of project operation. These features would alleviate effects caused by an outlet. The conclusions regarding potential impacts are based on the best available information. However, the eventual occurrence of any effects is highly dependent on the eventual

length of operation and the final operational constraints. Therefore, there is a high level of uncertainty with respect to the actual occurrence, location, and timing of potential effects. Extensive monitoring is proposed to: (1) Establish a reliable reflection of baseline conditions on the Sheyenne River prior to outlet operation, (2) Document expected level of effects associated with outlet operation, (3) Monitor the effectiveness of mitigation features to determine if modifications are needed, and (4) Ensure that mitigation features were sufficient to allow recovery of aquatic resources on the Sheyenne River once operation of the outlet has ceased. Monitoring activities to establish baseline conditions and monitoring costs for the first 10 years of operation are proposed as first costs. Subsequent monitoring and any required mitigation would be the responsibility of the local sponsor. At the cessation of the project, the monitoring may suggest the need for total restoration of the system. The need and costs for this restoration cannot be identified at this time and would require additional authorization. In addition to the monitoring features listed above, the following monitoring programs are proposed. Examples of parameters to monitor and frequency of monitoring are also provided. See Figure 6-6 for potential locations of monitoring sites and Appendix C for more detail on monitoring procedures. The final monitoring protocol would require additional coordination with agencies.

Groundwater Monitoring

- Reactivation of monitoring wells at four established sites.
- Installation of a total of 48 additional monitoring sites at 16 locations along the Sheyenne River.
- Groundwater monitoring locations would be monitored continuously for groundwater elevation, and would be related to Sheyenne River stage gages.

Water Quality/Flow Monitoring

- Installation of 15 data loggers (14 on the Sheyenne and Red Rivers and 1 in the regulation reservoir).
- Each of the data loggers could be set up to collect seven environmental parameters: dissolved oxygen (DO), conductivity, temperature, salinity, turbidity, chloride, and total dissolved solids (TDS). The data loggers could be set to record each parameter once every half-hour.

Erosion Monitoring

- Surveying of established cross sections on the Sheyenne River.
- Sediment monitoring would be implemented to track sediment transport (turbidity) in conjunction with the water quality gaging stations to track actual trends in the river.

Aquatic and Invasive Species Monitoring

- Periodic surveys of established aquatic habitat cross sections on the Sheyenne River. Measurements would be taken along multiple transects at each sampling site. Parameters include: river surface width, depths at width intervals, flow rates at width intervals, substrate types at width intervals, submergent vegetative cover, and bank slopes.

- Periodic surveys of fish, mussel, macrophytes, macroinvetebrates, and algae on the Sheyenne and Red Rivers. Several biota groups vary in composition seasonally and may require variable monitoring procedures. Algae are known to show seasonal succession, and macroinvertebrates show seasonal succession in both species composition and life-stage occurrence. Fishes shift habitat preferences seasonally, and fish larvae and juveniles appear in samples at different times of the year. Baseline data may suggest a need to adjust sampling season and/or frequency for certain groups.

Riparian Vegetation Monitoring

- Establishment of baseline conditions. There is a need to accurately identify vegetative cover types and in turn locate target species, target communities, and general communities of interest.
- Establishment of permanent transects on acquired mitigation lands. All monitoring sites would be permanent sites and would be established before pumping begins from the outlet. At least one season of data would be collected before pumping to serve as a baseline. Locations and community composition would be determined.
- Monitor populations of species of concern in the Sheyenne Delta. Target species and target communities refer to species or communities that are considered to be vulnerable or critically imperiled by the North Dakota Natural Heritage Program (S1-S3). Number of populations, frequency, and density information may be collected.

Cultural Resources

- Monitor protected sites to ensure protection was adequate. Annual monitoring (odd years on land and even years in canoes) to yield qualitative and quantitative data: even years would visually assess existing and new cutbank exposures; odd years would measure the progress of riverbank erosion against established datum points.
- Periodic survey to determine if additional sites are in need of protection. The annual monitoring would identify any new sites that are eroding and need further evaluation and possibly protection or data recovery

SCENARIO FUTURE

Table 6-9 is a summary impact matrix. More detailed discussion is presented in the following sections and in the Technical Appendices.

Future Without Project

Devils Lake is a landlocked lake, making it more difficult to estimate the frequency of future lake levels than for a simpler system, such as a river. Because of uncertainty and differing scientific opinions regarding future climatic conditions in the Devils Lake basin, an alternative future, based on a scenario analysis, has also been developed. The scenario-based future is an alternate future to the stochastic-probability based future.

The alternatives were evaluated using this alternate future without condition, which assumes a continued wet climate scenario based on the climate sequence from 1993 through 1999 repeated until a natural overflow to the Sheyenne River occurred. The wet future scenario repeats the climatic and hydrologic conditions for the seven highest flow years in recent history for three cycles, causing the lake to overflow. The remaining years of the 50-year cycle were defined assuming climatic and hydrologic conditions similar to 1980 through 1999, and then 1980 through 1990, to compare the 50-year trace. The probability that the lake will rise exactly in this way is zero. Using data from the stochastic model, it is estimated that there is about a 5-percent chance that the lake will reach or exceed elevation 1459 feet msl sometime within the next 15 years and 9.4 percent within the next 50 years.

The probability of a continued wet future resulting in a natural overflow is low; therefore, the likelihood of the impacts that are identified for the natural overflow event, the erosion of a natural outlet, and the dam on Tolna Coulee to actually occur are small. Likewise, the possibility of realizing the benefits of preventing a natural overflow is also small. In contrast, the probability of the impacts resulting from the operation of a constructed outlet to occur would be high. An outlet would reduce the likelihood of a natural overflow event by about one-half (from 9.4 percent to 4.1 percent).

Social Resources

Population Relocation

There are approximately 688 people living in the area along the overflow route through Tolna Coulee, estimated using 2000 Census data for census block groups along the coulee. The route passes through a rural area, and it is unlikely that any population relocations would be induced by the overflow through the coulee. An uncontrolled overflow with an expected discharge of 550 cfs would likely result in significant flooding along the Sheyenne River between the overflow discharge point and Lake Ashtabula. The Devils Lake overflows would augment extant flows in the Sheyenne River. Depending on hydrologic conditions in the river during the duration of the overflow,

Table 6-9 - Scenario Analysis Impact Matrix

Resource Category	Alternative			
	Future Without Condition	Expanded Infrastructure Protection	Upper Basin Storage	Pelican Lake Outlet (Preferred Alternative)
Natural Resources	Fishery in lake will continue to improve to a point. Eventually lake will recede and fishery will decline. Potential for new species to be introduced due to recreation and creation of new habitat. Continued construction of levees and roads could affect resources. About 500 acres would be affected. Infrastructure protection would have limited effect on probability of natural overflow, lake levels, and resultant effects. Construction activities would have temporary effect on aquatic habitat such as turbidity. Little long-term effect on Devils Lake fishery. Natural overflow could have significant downstream effects on fishery, erosion, water quality, and groundwater depending on magnitude of event. Risk of biota transfer from natural causes and recreational users. Devils Lake and Red River species are similar.	Would have limited effect probability of natural overflow, lake levels, and resultant effects. Construction activities would have temporary effect on aquatic habitat such as turbidity. Little long-term effect on fishery. About 3,000 acres of lake bay type habitat would be affected by changed hydrology. Previously developed areas may be reclaimed. Little change from Future Without condition.	Upper Basin Storage would be greatly expanded over current or anticipated levels. Upper Basin Storage would reduce runoff to lake, resulting in lake levels about 1 foot lower. Some fresher water would be retained in upper basin. Would prevent inundation of some land areas and loss of habitat. About 65 percent of the sites are in agricultural uses. Would result in the loss of agricultural uses and an increase in wetland habitats and values. Little effect on probability of natural overflow. Increase in wetland and grassland habitat.	Most fresh inflow removed before it enters Devils Lake. Lake reaches lower levels sooner, increase in TDS and sulfate over without-project condition. Upper basin lakes used for storage, subject to increased fluctuation resulting in decreased habitat value. Lake Alice National Wildlife Refuge affected, requiring compatibility statement. Lower lake level would expose shoreline sooner, resulting in quicker recovery of terrestrial habitat. There are 6, 213, and 82 Natural Heritage sites located within 1/4 mile of upper Sheyenne, lower Sheyenne, and Red River, respectively. Limited effect due to operation constrained by water quality and channel capacity. Increased groundwater could affect composition of riparian community. Changes in water quality and flow could have effect on aquatic community. Increased groundwater level would affect soil salinity, land uses, composition of habitat, and access to and across river. Biota transfer is issue with outlet. Possibility of transfer and introduction of new species would increase. Potential for spread of Eurasian watermilfoil. Sand filter designed to minimize possibility of biota transfer. Aquatic resource recovery facilitated through mitigation features including erosion protection and bypass channels.
Cultural Resources	Excavation of borrow material, construction of temporary levees, raising the City of Devils Lake levee, and relocating houses and utilities all have potential to adversely affect cultural resources, as do inundation and wave-caused erosion at Devils Lake and eventually Stump Lakes. Natural overflow would affect cultural resources sites along Tolna Coulee and the banks of the Sheyenne River through erosion, inundation, and deposition.	Same effects as future without, plus additional impacts to cultural resources where earth dams constructed and at borrow areas used for same.	Expansion of upper basin storage may result in inundation of cultural resources located at the restored wetlands. Construction of outlet structures may also damage cultural resources sites.	Pelican Lake outlet has yet to be surveyed for cultural resources. Cultural resources sites along the outlet alignment would be impacted by construction. A pipeline outlet would impact a narrower corridor than an open channel outlet. Known site at confluence of Peterson Coulee and Sheyenne River needs evaluation of National Register eligibility and may need mitigation excavation prior to construction. Pipeline easier to route around any significant cultural resources than open channel. Increased quantity and duration of high water in Sheyenne River would cause increased erosion of cultural resources sites along its banks over what occurs naturally. Mitigation of impacts to cultural resources sites along Sheyenne River will be necessary.

Table 6-9 – (Continued)

Resource Category	Alternative			
	Future Without Condition	Expanded Infrastructure Protection	Upper Basin Storage	Pelican Lake Outlet (Preferred Alternative)
Social Resources	Among most of the evaluation categories, the impacts would be comparable to the no-overflow future condition. Some categories differ in that the effects would be somewhat worse. These include Population Relocation, Public Health and Safety, Community Growth, Controversy, and Agriculture, which would worsen in magnitude from substantially adverse to significantly adverse effect, for Aesthetic Values, which would worsen from minor adverse to significantly adverse, and for Recreation, which would worsen from substantially positive effect to substantially adverse effect.	The only significant effect caused by the Infrastructure Protection Plan is in the category of Public Safety. This is a positive effect resulting from the significant increase in safety for those living in areas protected by the roads-as-levees and for those motorists traveling along the roadways. All other categories are rated as having either no effect or a minor effect.	In general, Upper Basin Storage will have a minor positive effect on most social and economic evaluation categories compared with the without-project condition. An additional element of controversy would be added by implementing a plan that is not acceptable locally or viewed as ineffective in reducing lake levels. An additional negative aspect related to land use would be added as well. Conversion of approximately 40,000 acres of the depressions to storage would preclude continuation of normal agricultural operations on these lands.	Generally, the Pelican Lake outlet is expected to have minor to substantially positive social and economic impacts compared to the without-project condition. Substantial improvements anticipated with the outlet in place would be expected in the areas of recreation, community cohesion, community growth, controversy, employment, regional growth, and business activity. A substantial adverse effect would be anticipated for energy resources due to the significant amount of energy required to operate the pumps.
Other States, Nations, and Tribal Resources	Natural conditions would prevail. No conflict with Boundary Waters Treaty would be expected. Controversy over boundary with Spirit Lake Tribe may continue. Environmental justice issues would continue. Damages due to rising lake levels would continue. Downstream effects may be significant depending on magnitude of natural overflow. Biota transfer issues may be a concern, although overflow would be natural.	Not much change from future without-project conditions. Road raise and levee construction would continue as needed. Higher degree of infrastructure protection would be needed due to chance of higher lake levels. Downstream areas may also need protection depending on magnitude of natural overflow.	Not much change from future without-project conditions. Upper Basin Storage is preferred by other states and Canada.	Outlets in general are not acceptable to downstream interests. Minnesota and Canada have opposed outlets due to water quality and biota transfer concerns. Sand filter would minimize concerns associated with biota transfer. Outlet may not be in compliance with Boundary Waters Treaty. Spirit Lake Tribe in past has opposed outlets from west end. Lake may continue to rise in spite of outlet and overflow naturally. Environmental Justice is complied with; however, low income and minorities affected by outlet.

there is significant potential to exceed the 600-cfs bank-full capacity of the upper Sheyenne River.

Flooding along the Sheyenne River associated with an overflow might induce some relocations away from the river to higher ground. Table 6-7 profiles land use along the Sheyenne River above and below Baldhill Dam. One set of land use profiles applies to a river corridor extending ¼ mile from each bank. The other set of land use profiles applies to the Sheyenne River floodplain. The floodplain is consistent with without-project river flooding and may not apply to flooding associated with a Devils Lake overflow. As indicated in this table, land use above the dam is primarily agricultural (cropland and grassland). There is more urban land below Baldhill Dam, but the bank-full capacity of the river below the dam is much more capable of accommodating Devils Lake overflows without inducing flooding.

Some flooding damage along the Sheyenne River would result from a Devils Lake overflow. Homeowners along the river may be induced to relocate in response to a Devils Lake overflow. The extent to which permanent relocations would occur would depend on a variety of factors, including the severity and duration of flooding, the particular locations of property at risk, and decisions by individual homeowners.

Environmental Justice – Social Criteria

No disproportionate impact on minority populations is expected by an overflow along the Tolna Coulee overflow route. Some pasture and cropland on the Fort Totten Indian Reservation would be inundated if Devils Lake reached overflow elevation, but significant damages would not be expected due to prior relocations of structures at risk. An overflow would not be expected to disproportionately affect minority populations downstream along the Sheyenne River and Red River.

Public Health

An overflow from Devils Lake has the potential to affect human health primarily through water quality effects on the Sheyenne River and Red River. In high concentrations, sulfates can induce diarrhea. However, there are no swimming advisories on Devils Lake. In addition, water supply purveyors along the Sheyenne River and Red River may need to seek alternate sources. Given the time required to achieve overflow elevation, there would be sufficient time to diversify water supplies, assuming people are willing to take action while there is still sufficient time to react.

As discussed previously, there is also the potential for a lake overflow to increase the mercury content of edible fish in the Sheyenne River and Red River. The bioaccumulation of mercury could adversely affect the health of fish consumers if the fish consumption advisory from the North Dakota Department of Health is not heeded.

Public Safety

The potential safety effects of an overflow to the Sheyenne River through Tolna Coulee are those associated with consequent flooding. Armoring the overflow route would control scour and thereby limit the discharge and consequent downstream flooding. The advance warning of a Devils Lake overflow should minimize the hazards, but there is still potential for individuals to not fully recognize the risks and expose themselves to the flood hazard.

Noise Effects

No noise effects are anticipated to result from an overflow to the Sheyenne River.

Aesthetic Values

An overflow through Tolna Coulee to the Sheyenne River could have adverse short-term effects on the aesthetics of the river's riparian corridor. The augmented flows of the river could accelerate erosion-deposition patterns along the river and could damage the riparian zone. Aesthetics for canoeists or other river recreationists could be adversely affected.

Recreation

Recreation along the upper Sheyenne River (i.e., from the outlet discharge to Lake Ashtabula) is limited to low-intensity canoeing and swimming. The lake was impounded by Baldhill Dam, which was completed in 1950. This Corps project was primarily intended to serve as a water supply facility to augment low flows on the Sheyenne River and on the Red River, but it is currently operated for flood control and recreation purposes, as well. The dam is located approximately 12 miles upstream from Valley City. Lake Ashtabula is 27 miles long and has an area of 5,234 acres. The lake is a popular recreation resource. In 2000, the lake received 165,200 visitors who spent more than 2.6 million visitor hours at the lake. The lake has a popular sport fishery consisting of walleye, northern pike, white bass, yellow perch, and black bullheads. Its facilities include four campgrounds, three swim areas, seven boat ramps, and 250 acres of associated lands. The maximum depth of the lake is 42 feet. User surveys indicate that recreationists on Lake Ashtabula pursue the following activities: fishing (55 percent), boating (36 percent), camping (25 percent), picnicking (23 percent), hunting (17 percent), swimming (15 percent), sightseeing (7 percent), and water skiing (4 percent). Approximately 98 percent of the lake recreation occurs during the open water season.

As discussed above, an overflow to the Sheyenne River could have adverse consequences for recreation along the river by creating hazardous conditions for canoeists and swimmers or by reducing the aesthetics of the riparian zone.

An overflow could also adversely affect the fishery in Lake Ashtabula. An overflow from Devils Lake could have severe water quality impacts on the Sheyenne River, since

the lake would overflow from its east end, which has the lowest water quality in Devils Lake. Since fishing accounts for 55 percent of Lake Ashtabula's recreation activities, an adverse impact on the fishery from an overflow could have a disproportionate impact on the lake's recreation.

Some fishermen along the Sheyenne River and Red River have expressed concern that an overflow or an outlet could release striped bass into these rivers and damage the fishery. Discussions with fishery biologists with the North Dakota Department of Game and Fish indicate that a release of striped bass is unlikely and that their propagation is unlikely in these riverine conditions should such a release occur. In addition, on the basis of angler surveys along the Red River, it is also unlikely that additional amounts of methyl mercury transferred from the lake to these rivers would have any adverse effects on fishing. The fish consumption advisory was previously discussed. The largest fish with the greatest bioaccumulation of mercury are channel catfish, and this is primarily a catch-and-release species.

Community Growth/Development

For those residents living near Tolna Coulee and downstream communities along the Sheyenne River, the prospect of an overflow from Devils Lake is alarming. The perceived risk has similar effects on those communities as were described above for the rising lake. However, these communities seem to be more concerned with an outlet from Devils Lake than with the possibility of an overflow. The perceived higher probability and lower consequence of an outlet seem to outweigh the lower probability and higher consequence of an overflow. If an overflow were more imminent, the balance of perceived risks would no doubt begin to change.

Community Cohesion

Downstream along the Sheyenne River, there appears to be strong community support for the belief that an overflow from Devils Lake needs to be avoided.

Land Use/Long-Term Productivity

The overflow route from Devils Lake down Tolna Coulee is approximately 14 miles. Assuming a 50-foot width of the overflow, approximately 85 acres in the coulee would be directly affected. An overflow is not expected to affect land use along or downstream along the Sheyenne River. It is anticipated that flooding associated with an overflow would be contained in the existing floodplain of the Sheyenne River.

Controversy

Communities potentially affected by an overflow are sympathetic to those affected by the rising lake. There is widespread recognition in downstream communities that an overflow would be catastrophic. Some members of these communities have adamantly expressed publicly that increased upper basin storage is the solution to the entire problem, and have

suggested that this alternative is being dismissed for political, rather than technical, reasons. The controversy reflects their concerns about the consequences of an overflow and their suspicions about the equity of trade-offs in the State's support for an outlet.

Environmental Justice – Economic Criteria

The downstream counties in North Dakota and Minnesota that would be affected by a Devils Lake overflow have incomes and poverty levels that are consistent with State and U.S. averages. Therefore, disproportionate economic impacts on low income and minority groups are not expected.

Transportation

An overflow of Devils Lake down Tolna Coulee could affect local roads along the overflow route. It could also induce flooding along the Sheyenne River with consequent damage to transportation infrastructure, including roads and bridges.

Agriculture

An overflow through Tolna Coulee would effectively eliminate the agricultural potential of lands along the overflow route. Assuming a 14-mile length and a 50-foot width, approximately 85 acres of agricultural land would be affected. In addition, farms that withdraw water from the Sheyenne River or the Red River for irrigation could suffer reduced crop yields associated with the lower river water quality that results from an overflow. These effects on irrigated agriculture are included in the NED analysis. Also, higher flows in the Sheyenne River could affect some farms along the river. Some agricultural property could be damaged from increased flooding, including lands, equipment, and structures.

Also, some farms straddle the river and use fords to move their livestock or their farm equipment from one side of the river to the other. These river crossings may be impeded or prohibited by additional river flow associated with an overflow.

Energy Resources/Use

An overflow to the Sheyenne River is not expected to have significant impacts on energy production or consumption.

Employment

An overflow to the Sheyenne River is not expected to have significant employment effects. However, employment could be affected by the high lake levels associated with an overflow.

Regional Growth

An overflow to the Sheyenne River is not expected to influence the growth potential for economies of downstream communities.

Business Activity

An overflow of Devils Lake through Tolna Coulee is not expected to have significant impacts on business activity in the lake area or downstream along the Sheyenne River.

Property Values

An overflow from Devils Lake through Tolna Coulee could diminish property values along the overflow route and downstream along the Sheyenne River and perhaps along the Red River. Flood damages to property and to the riparian zone would be the principal cause of lower property values. Properties affected would be limited to those lands in the floodplain.

Fiscal Effects

An overflow from Devils Lake through Tolna Coulee could have adverse fiscal effects on communities downstream along the Sheyenne River. These communities could be forced to make road and bridge repairs if local infrastructure is damaged by flooding that could result from an overflow.

Public Facilities/Services

An overflow of Devils Lake through Tolna Coulee is not expected to affect public facilities or services beyond those previously discussed.

Downstream Water Users Effects

It is almost certain that the municipal water treatment facility at Valley City would be the most adversely affected by an overflow. It would experience the highest raw water constituent concentrations. Furthermore, Valley City's alternative raw water supply options are not likely to be satisfactory. Its existing surface water wells are not likely to provide water of substantially better quality than that of the Sheyenne River, and obtaining water from the nearest surficial aquifer is likely to be prohibitively expensive. During overflow periods, Valley City's municipal water treatment facility can improve the river water quality by softening and disinfection so as to make it usable for non-consumptive uses. An alternate drinking water supply would need to be provided for the residents.

At Fargo and Grand Forks, the situation is likely to be somewhat better. The raw water, diluted by adjoining streams, would show constituent concentrations that are less extreme—though still greatly in excess of applicable standards. Using the current raw

water supplies and existing treatment operations, the Fargo and Grand Forks municipal water treatment facilities will not be able to meet applicable secondary standards. The City of Fargo's principal intake on the Red River is above the confluence of the Sheyenne River. Each of the two cities has an alternate water supply source that, while not ideal, may be used successfully during Stump Lake overflow periods. Providing bottled water for consumptive use, however, may also be necessary during these periods.

Farther downstream, at the municipal water treatment facilities at Grafton, Drayton, Pembina, Morris, and Letelier, modeling indicates that dealing with the effects of an overflow may be much less problematic. Dilution by low-TDS tributaries upstream of these communities results in raw water showing peak constituent concentrations much lower than those of the other three municipal water treatment facilities upstream. Furthermore, the dilution reduces the number of months during which constituent concentrations exceed the upper limits of what is normally experienced. Existing treatment operations, therefore, may be sufficient to bring hardness and TDS down to acceptable levels even during overflow periods. Sulfate and sodium levels would remain high, however, so that bottled water (or a suitable alternative) may have to be provided, particularly for at-risk members of the communities.

The effects on the fish hatchery would be more significant than those described for the outlet under the stochastic approach. The type of effects are similar, but it may not be feasible to find an alternate water supply for the hatchery.

Natural Resources

Devils Lake

The water quality of the Devils Lake chain would be improved by the eastward movement of fresh water, displacing and diluting the saltier water in East Devils Lake and Stump Lake. Appendix A shows potential lake level and water quality results from a wet future scenario and moderate futures.

The future without conditions would be similar to the stochastic discussion except that it is assumed that the lake would overflow to the Sheyenne River. As a result, this would improve the overall water quality of the lake due to the outflow from the east end of the lake system. There would be a significant increase in natural reproduction in the lake and an expansion of the fishery and aquatic habitat. This may or may not be considered a benefit because there may be a large increase in the number of small fish and a decrease in the number of large fish. Because of the larger lake area and suitable habitat, it may be more of a challenge for anglers. Freshening of and increasing the size of the lake is generally considered a benefit.

If the lake were to overflow, about 24,000 acres of additional land would be inundated by the surcharge to elevation 1461. This would inundate about 20,000 acres, resulting in the loss of upland habitat and the gain of aquatic habitat.

Downstream Areas

Water Quality

An overflow event under this scenario would have a peak discharge of about 550 cfs. Average flows are much lower (see Appendix A, "Hydrologic and Water Quality Monitoring"). Overbank flooding associated with a natural overflow event would occur. About 7,500 acres upstream of Lake Ashtabula and about 1,000 acres downstream of Baldhill Dam would be subject to inundation. On the Red River, no effects are anticipated since the additional flows would be contained well within the channel limits during the summer.

Water quality effects of a natural overflow would exceed water quality standards on the Sheyenne River and the Red River. Water quality would be degraded on the Sheyenne and Red Rivers over existing conditions as a result of the natural overflow. A new baseline would be established. Nutrient loading would also increase on the Sheyenne and Red Rivers as a result of an overflow. Information in Appendix A shows water quality conditions on the Sheyenne River at Cooperstown for the natural overflow. Other alternatives are discussed in later sections of this report/EIS.

Geomorphology

A wet future in the Devils Lake basin would also probably result in a wet future in other basins. The wetter climate on the Sheyenne River in combination with a natural overflow would result in increased erosion and sedimentation. These conditions would result in a wider channel with a longer meander length and larger meander amplitude. Erosion would increase significantly. The loss of riparian vegetation would magnify this effect.

Increases in erosion and deposition from a natural overflow could be severe. Increased bedload movement potentially could affect fish adversely due to increased turbidity or sedimentation. Increased sedimentation, in turn, could lead to increased embeddedness or even the complete burying of hard substrates (i.e., gravel, cobble, and boulder).

Terrestrial

Effects on the terrestrial communities would range from losses associated with erosion to changes in vegetation composition and density as a result of saturated soil conditions from prolonged flooding and elevated groundwater levels. The degree of change that may occur due to changes in soil conditions cannot be quantified. However, it is likely that a large portion of the riparian vegetation would shift from woods to a more open community type, resulting in a concurrent change in animal species composition along the river. Changes in water quality to a more saline condition could also influence the amount and type of vegetation along the river. Some of the larger overstory forest trees may survive a year or longer but with reduced vigor. Once the overflow event is completed, recovery of these areas through succession would occur, which could take decades in some areas.

Aquatic

Depth, velocity, substrate, and cover are flow-dependent physical habitat features, which play a vital role in governing the distribution and abundance of stream fishes and macroinvertebrates. Because changes in stream flow translate into changes in these habitat features, stream flow alteration can adversely alter the structure, function, and composition of stream communities by altering the availability of various habitat types on both spatial and temporal scales. The seasonal hydrograph of most riverine systems provides a variety of flow-related habitat conditions. Alteration of the natural hydrograph often results in the loss of one or more important habitat types, resulting in a habitat bottleneck with resulting reduced system productivity.

Significant adverse impacts on aquatic habitat availability and suitability would be expected with an overflow event. The most flow-sensitive habitat types, such as riffles where shallow, fast habitats predominate, would be almost entirely absent from the habitat matrix for an extended time period. Hydraulic and habitat modeling indicates that at discharges above approximately 400 cfs the habitat matrix would be dominated by deep pool habitat. The loss of these habitat types would adversely affect species life stages, which are dependent on shallow, fast water for spawning, feeding, or other life requisites provided by riffles. Other habitat types such as shallow, slow habitat would also be significantly reduced. The largest adverse impacts on habitat would likely occur in the Sheyenne River above Lake Ashtabula. Of the fish species present in the Sheyenne River that might be considered obligate riverine species, all have one or more life stages that prefer shallow pool, slow riffle, or fast riffle habitat. The chronic loss of these habitat types with an overflow event would have significant adverse impacts on obligate riverine species.

In addition to the adverse impacts on habitat caused by the significant changes in stream flow, the physical changes in channel geometry caused by the increased occurrence of bank-full or channel-forming flows would result in a loss of suitable habitat for many aquatic species.

The projected changes in TDS concentrations in the Sheyenne River would also contribute to adverse impacts on aquatic resources. An evaluation of the toxicity of ambient waters from the Sheyenne River, Devils Lake, and East Devils Lake on fathead minnows, *Cerodaphnia spp*. and algae, revealed that East Devils Lake water (TDS concentrations of about 5,700 ppm) was acutely lethal to *Cerodaphnia spp*. Initially, a natural overflow of Devils Lake would result in TDS concentrations approaching/ exceeding 5,700 ppm. This projected TDS level would be acutely toxic to *Cerodaphnia spp.* and potentially lethal to other important food chain organisms. The loss of food-chain organisms would cascade through the food chain, resulting in lost productivity.

Water quality would be worse under the overflow alternative and would be sufficiently poor that sensitive fish throughout the Sheyenne River would be slightly to moderately affected. Unionids would be highly affected by chloride levels.

Total dissolved solids levels would be moderate to high throughout the Red River, causing exceedences of water quality standards, perhaps affecting sensitive fish. Chloride levels are expected to exceed the 100-mg/l standard only in the upstream portion of the Red River and then less than 1 percent of the time. However, the maximum level may still be high enough to affect unionids. Hydrology and habitat are not expected to be affected.

The anticipated mixing of waters associated with a natural spill could result in algal blooms with significant adverse impacts on aquatic resources. Bioassay studies with various mixtures of Sheyenne River water and Devils Lake water caused a statistically significant stimulation of algal growth. Increases in algal concentrations would have synergistic effects on other water quality parameters, including dissolved oxygen concentrations, CO_2 concentrations, pH, alkalinity, and the carbonate-bicarbonate balance.

The loss of habitat due to increased flows, changes in channel geometry, loss of overbank cover and sedimentation, coupled with changes in water quality and algal growth, would all contribute to a substantial change in the aquatic community present in the Sheyenne River. Projected TDS levels associated with the overflow event would adversely influence fish reproduction and result in lost-year classes. The cumulative result of all these changes would be a decrease in diversity and density of aquatic species in the Sheyenne River. The threshold chloride levels for some aquatic species, such as mussels, would be far exceeded with a natural overflow and could, therefore, be eliminated from the system.

Erosion and sedimentation would increase with a natural overflow of this magnitude. It is expected that there would be an increase in the amount of sediment deposited in the upper end of Lake Ashtabula. Combined with the increase in sulfate and TDS levels, this would greatly influence the aquatic resources in the lake. A decrease in species diversity and abundance in Lake Ashtabula would be expected.

The changes in the aquatic community would persist for many years after the overflow event is completed, especially on the Sheyenne River above Lake Ashtabula. The only source for recolonization in this reach of the river would be from fish populations above the insertion point of the spill, as Baldhill Dam is a barrier to upstream migration of fish.

Irrigation and Soil Salinity

For irrigators, the "No-Action" (natural spill) alternative represents a substantial salinity and sodicity hazard over the no-spill condition. Using the more conservative *Blended-Water-Only* dataset, 2,750 of the 12,903 irrigated acres along the Sheyenne River and Red River combined (21.3 percent) would fall in the Low, Moderate, or High salinity hazard classes. Similarly, using the *Blended-Water-Only* dataset, 2,416 of the 12,903 irrigated acres along the Sheyenne River and Red River combined (18.7 percent) would fall in the Low, Moderate, or High sodicity hazard classes. The "No-Action" (natural

spill) alternative would generate new sodicity hazards on 2,416 acres that would have had a sodicity hazard class of none/slight.

Soil TDS and sodium absorption ratio (SAR) values associated with the "No-Action" (natural spill) alternative would be sufficiently elevated that they would exceed recommended levels for many soils. Accordingly, salinization hazards under the no-action alternative are significant.

Most soils potentially affected by flooding or groundwater intrusion under the no-action (natural spill) alternative would have moderate to severe hazards, indicating that the effects would adversely affect land use, soil conditions, and salt-intolerant vegetation. Again, the effects of the no-action alternative would be influenced by the floodplain morphology of the Sheyenne River. More severe salinization hazards would be expected upstream of Lake Ashtabula where regular overbank flooding would be a more common occurrence and saline or salinizable soils are more extensive. Downstream of Baldhill Dam, the effects of the no-action (natural spill) alternative would be severe, but would likely be confined to channeled and regularly flooded areas adjacent to the river and to abandoned meanders and oxbow lakes.

Biota Transfer

Biota transfer is also a concern with a natural overflow to the Sheyenne River. Under the no-action (natural spill) future, the eventual discharge of Stump Lake water to the Sheyenne River would affect salinity levels significantly. An overflow would overtop the river channel and result in erosion and bank scour. These flows in and of themselves would not provide a suitable habitat for Devils Lake species. However, the resulting salinity changes in Lake Ashtabula could substantially affect communities, thereby disadvantaging resident species and providing favorable habitat for invasive halophiles from Devils Lake. This likely would create salinity levels in Lake Ashtabula that would be high enough to stress many resident species, and would probably facilitate the invasion of several species into the lake. Such species would potentially include "marine" Cyanobacteria (e.g., *Nodularia spumigena*) and green algae (e.g., *Enteromorpha intestinalis* and *E. prolifera*), wigeongrass (*Ruppia maritima*), and several "marine" rotifers, among others.

A natural overflow would allow any species in Devils Lake to enter the Red River drainage. In addition, the higher flows may enhance the distribution of Eurasian watermilfoil in the Red River drainage. However, this expansion of milfoil may occur without an overflow because of natural conditions.

Cultural Resources

Excavating borrow material, constructing temporary levees, raising the City of Devils Lake levee, and relocating houses and utilities all have potential to adversely affect cultural resources, as do inundation and wave-caused erosion at Devils Lake and eventually Stump Lakes. A natural overflow would affect cultural resources sites along

Tolna Coulee and along the banks of the Sheyenne River through erosion, inundation, and deposition.

Other States, Nations, and Tribal Resources

The fluctuating lake levels affect low-income communities and lands on the Fort Totten Indian Reservation. It is not known at this time if any traditional cultural properties would be affected under the future without-project conditions.

The Province of Manitoba has established an ongoing effort to manage nutrients in the Red River and Lake Winnipeg. It is expected that these efforts will reduce phosphorus and other nutrients in Lake Winnipeg. Over the next several years, nutrient objectives will be developed and policies proposed.

Because it would be a natural overflow, the effects to other states and nations would be considered the natural conditions. The effects would be significant and would interfere with any ongoing efforts to restore riparian areas, reintroduce the sturgeon, and reduce nutrient loading to the downstream areas. Efforts to restore the riparian corridor along the Red River should improve downstream water quality and improve the recovery of the system.

Mitigation

Impacts and mitigation needs associated with infrastructure protection measures would be similar to the stochastic analysis except that they would possibly occur at a different time due to hydrologic conditions. There is no mitigation associated with an overflow because it would be a natural event.

UPPER BASIN STORAGE

Social Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Natural Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Cultural Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Other States, Nations, and Tribal Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Mitigation

Impacts and mitigation needs associated with upper basin storage would be similar to the stochastic analysis accept that they would possibly occur at a different time due to hydrologic conditions. There is no mitigation associated with an overflow because it would be a natural event.

EXPANDED INFRASTRUCTURE PROTECTION

Social Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Natural Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Cultural Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Other States, Nations, and Tribal Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Mitigation

Impacts and mitigation needs associated with expanded infrastructure protection would be similar to the stochastic analysis except that they would possibly occur at a different time due to hydrologic conditions. There is no mitigation associated with an overflow because it would be a natural event.

OUTLET PLAN (Pelican Lake Preferred Alternative)

Social Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Natural Resources

Effects in the Devils Lake basin would be the same as those described under the stochastic analysis. An outlet would prevent the natural overflow under the wet scenario future; therefore, the downstream effects of an overflow described under the scenario future without-project conditions would not occur. However, downstream effects similar to those described under the stochastic outlet alternative would occur. The downstream effects may last for a longer period of time and some effects such as flow and erosion would be greater than under the stochastic analysis because more water may be pumped out of Devils Lake under the wetter conditions. Water quality effects may be somewhat different due to fresher water.

Overall, the effects of an outlet on terrestrial and aquatic resources, biota transfer, soil salinity, and other resources are similar to those for the stochastic outlet alternative. The types of effects caused by the outlet operation or a natural overflow are similar. The likelihood of the effects is dependent on the risk and probability of the future conditions to occur.

Under the scenario future, the lake would still rise to 1457 with the outlet in operation. Therefore, infrastructure protection measures would still be required and impacts associated with construction would also occur in addition to those of the outlet operation.

Because the scenario is based on a wet climate, the pumping may last longer and greater quantities may be pumped out. Therefore, the impacts described for the stochastic analysis would last longer and the flow effects would be greater. For example, there would be more erosion, aquatic effects from flow would be the same type but would be of a greater magnitude, soil salinity effects would also be of the same type but irrigators and land users would be subject to those effects for a longer period.

Cultural Resources

Effects in the Devils Lake basin would be similar to those described under the stochastic analysis. Downstream effects would be similar to what would occur under the scenario future without-project conditions.

Effects may be somewhat greater than under the stochastic analysis due to the additional pumping and higher lake levels resulting from the wet scenario as described under scenario natural resources.

Other States, Nations, and Tribal Resources

Effects would be similar to those described under the stochastic analysis. An outlet would prevent a natural overflow under the wet scenario. An outlet would not prevent an overflow from occurring under all potential future climatic conditions analyzed under the stochastic analysis.

Mitigation

Impacts and mitigation needs associated with an outlet would be similar to the stochastic analysis except that they would possibly occur at a different time due to hydrologic conditions. An outlet would prevent a natural overflow under the scenario future. Even if an overflow did occur, there is no mitigation associated with it because it would be a natural event.

RISK AND UNCERTAINTY

There is considerable debate within the scientific community, however, regarding the stationarity of climate in the Devils Lake basin. In fact, it has been argued by some that climate in the Devils Lake basin may be nonstationary for a variety of reasons, such as the existence of natural climate cycles caused by global ocean and atmospheric circulation patterns or the existence of global warming due to anthropogenic causes.

To assess the effects of a hydroclimatological phenomenon on lake level probabilities of a terminal lake, both rainfall/runoff and evaporation are important considerations because they are cumulative in their impact and are subject to persistent weather patterns. If climate is nonstationary, then stage in a terminal lake such as Devils Lake will experience wide variability. Even small changes in precipitation or evaporation can have significant effects on lake levels, since these changes occur over the 3,800-square-mile drainage basin.

Table 6-10 illustrates the uncertainty in forecasting lake levels. It is a historic summary of projected probabilities of lake stages from 1994 through 1999. As can be seen, on many occasions actual stages were given only a very slight chance (1 to 3 percent) of occurring. The analysis shows that, from a probability standpoint, the current conditions at Devils Lake are indeed a rare event.

The uncertainty in forecasting lake levels has made it difficult to specifically identify the risks associated with the decision to build an outlet. Based on the probabilities in 1994 of Devils Lake rising in future years, deciding to invest in an outlet in 1994 would have been a risky proposition in terms of economic feasibility. In 1994, the risk was low that the lake would continue to rise, causing additional flood damage or additional investment in protecting the infrastructure. Hence, in 1994, an outlet was seen as not likely to be necessary. Conversely, the risk was high that, if an outlet were built, it would likely sit idle for most of the time and the investment would be open to criticism since the probability of the lake rising (from a 1994 perspective) was so low.

Table 6-10

Comparison of Lake Level Probability Estimates Made in 1994, 1995, 1998 and 1999 with the Actual Peak Lake Levels Reached from 1994 through 1999
Devils Lake, North Dakota

Year	Elevation	Indicated Probability of Reaching or Exceeding the Actual Lake Level			
		Estimates Made in Spring 1994	Estimates Made in Spring 1995	Estimates Made in Spring 1998	Estimates Made in Spring 1999
1994	1430.7	36%			
1995	1435.9	3%	12%		
1996	1437.8	3%	12%		
1997	1443.0	Less than 1%	2%		
1998	1444.7	Less than 1%	2%	42%	
1999	1447.5 *	Less than 1%	Less than 1%	6%	5%
1% Chance Level		1443.4	1446.6	1453.0	1453.4
0.2% Chance Level					1457.3

(*) Based on forecast made in April 1999.

Given the uncertainty and controversy around the ability to forecast future lake stages, a decision to proceed with an outlet had to consider risk avoidance. Given the experience of the last 10 years, one could view the construction of an outlet from a different perspective, as an insurance policy, rather than an investment. That is, what is the relative risk of not building an outlet, versus building an outlet, and not needing it? Risk avoidance in light of the rapid rise in lake elevation from 1993 to 1999 and the potential for continued rise in water levels was considered in evaluating the alternatives.

The Energy and Water Development Appropriations Act, 2003, Division D of Public Law 108-7, required the Corps to fully describe the justification of an emergency outlet in the project plan documents, to include the analysis of benefits and costs. Table 6-11 presents the relative benefit-cost ratios, expected lake stages, probabilities of those stages being reached or exceeded, and risks associated with building or not building the preferred outlet plan, the Pelican Lake 300-cfs outlet. The information is shown for the stochastic analysis, as well as for three scenarios evaluated.

Table 6-11

Comparison of Selected Outlet Plan and No Outlet

	Stochastic	Wet Scenario	1455 Scenario	1450 Scenario
Benefit-Cost Ratio				
of Outlet	0.19	1.54	0.55	0.13
Expected				
Stage w/o Outlet	1450.06	1460.6	1454.9	1450.0
Probability of Stage				
w/o Outlet be Exceeded	50%	5.5%	20.8%	50.6%
Expected Lake				
Stage w/ Outlet	1449.33	1457.5	1452.1	1448.9
Increased Risks		Natural Overflow		
w/o Outlet	Lake damages with	Lake damages with	Lake damages with	Lake damages with
	extra 0.5-ft.stage	extra 3.1-ft.stage	extra 2.8-ft.stage	extra 1.1-ft.stage
Increased Risks	Downstream Impacts	Downstream Impacts	Downstream Impacts	Downstream Impacts
w/ Outlet				

Note: The exceedence probabilities shown in the above table represent the likelihood of the respective lake stages being reached or exceeded during the next 50 years based on 10,000 traces used in the stochastic analysis. The benefit-cost ratios for the scenarios are not related to these probabilities, since a specific scenario is assumed to have a 100-percent chance of occurring for each scenario evaluated.

In considering risk for Devils Lake, it is important to understand the differences in regional damages between lake and river flooding. Typically, the Corps does not include regional damages in its economic analysis, even though such damages may occur in the region. When a river floods, the water recedes and the floodplain is available for use again. The risk of flooding in subsequent years is no higher than it was in the flooded year, and some reasonable use can be made of the floodplain. When Devils Lake hits a new high elevation, however, the land may not be available for many years. Over 80,000 acres of land have been inundated since 1993. Accordingly, the regional impacts may be very significant.

As discussed above, when the water level rises in a closed basin, it does not go back down except by evaporation. Additional flooding then accumulates upon the existing floodwaters. Depending on the climatic future, the lake may either go up or down, and any of the alternatives may be more or less effective. For a wet future scenario, a discharge from a natural overflow could approach 6,000 cfs, assuming the full extent of erosion, and carry as much as 940,000 cubic yards of material into the Sheyenne River. Water quality would be significantly affected, with sulfate concentrations increasing from a median base condition of about 200 mg/l to 1,600 mg/l, making alternative water supplies mandatory for downstream communities such as Valley City. Other communities, such as Fargo and Grand Forks, will have difficulty providing safe and aesthetically acceptable drinking water. A probability of full erosion occurring has not

been determined but would probably be small and, based on past emergency measures taken in the area, was assumed to be prevented in the future without-project condition.

The base condition for the wet future scenario shows the lake reaching an overflow elevation in about year 2015. The Pelican Lake 300-cfs outlet (preferred outlet plan) would limit the maximum stage to 1457 and generally result in lake stages about 3 feet lower than the base condition. The continued rise of the lake affects the viability of the regional economy and general well-being of the Devils Lake area. The farmland (approximately 50,000 acres of land within this 3-foot band), homes, roads, and other infrastructure features would not be flooded or affected by higher groundwater levels under this scenario.

As an example of a more moderate scenario, for a scenario where the lake would reach elevation 1455 without an outlet, the Pelican Lake 300-cfs outlet is able to limit the maximum stage to elevation 1452, or a 3-foot reduction, (with approximately 35,000 acres of land in this band).

Although there is a low probability of occurrence, the risks associated with a natural overflow, together with the opportunity to reduce the damages around Devils Lake with a reduced rate of rise on the lake, make the outlet plan the preferred option.

The infrastructure protection alternative only, without an outlet, does not address the potential effects of a natural overflow. However, under some climatic futures, the lake would continue to rise and overflow, even if an outlet were constructed. Many infrastructure protection measures would still be required, even with construction and operation of this outlet. From an economic standpoint, continuing to protect infrastructure features around the lake is a wise investment of funds, because the protection is constructed incrementally as needed and is shown to be cost-effective under the stochastic approach and the wet future scenario (benefit-cost ratios were not determined for this alternative for the moderate scenarios). The preferred outlet alternative is shown to be cost-effective under the wet future scenario, but not for the stochastic or other scenarios.

Using the stochastic analysis, an outlet would reduce the chance of an overflow from 9.4 percent to 4.6 percent (more than a 50-percent reduction in the chance of an overflow) over the without-project conditions. The risk still exists that, because of the limited effectiveness of a constrained outlet, the lake may still rise, it may still overflow, and residents may be disappointed that the outlet does not completely solve their flooding problem.

There is the investment risk of building an outlet that may not be needed. This can be inferred from the probability of the lake reaching or exceeding a particular elevation. Under the without-project future condition, there is a 50.6-percent chance that the lake will reach or exceed elevation 1450 over the next 50 years. Therefore, there is about a 50-percent chance that the lake will hold relatively steady or decline and that an outlet would be operated only minimally. On the basis of the scenarios analyzed, there is a

6.5-percent chance that in the next 15 years the lake will reach or exceed elevation 1458, the approximate lake stage showing economic viability. Therefore, there is about a 93.5-percent chance that if an outlet were built it would not be economically beneficial on a national level of evaluation.

As shown on Figure 6-8 and in Table 6-12, the relative risk of building or not building an outlet could be expressed in terms of costs that could be expected with a particular scenario occurring in the future. Figure 6-8 illustrates the relationship between future lake elevation and the expected benefit-cost ratio for an outlet. The figure shows that for an outlet to be economically feasible, the lake must reach an elevation of at least 1458. If the lake is expected to rise above 1458, the expected benefit-cost ratio will increase. Quadrants A and B represent all scenarios in which the lake will not reach 1458, a situation with a 93.5-percent chance of occurrence. Moderate Future 1 (lake peak of 1450) may be representative of these scenarios. An outlet built among these scenarios will not be feasible. For example, an outlet built under the Moderate Future 1 scenario will cost approximately $186.5 million, but will reduce damages around the lake and downstream along the Sheyenne and Red Rivers by only $46 million.

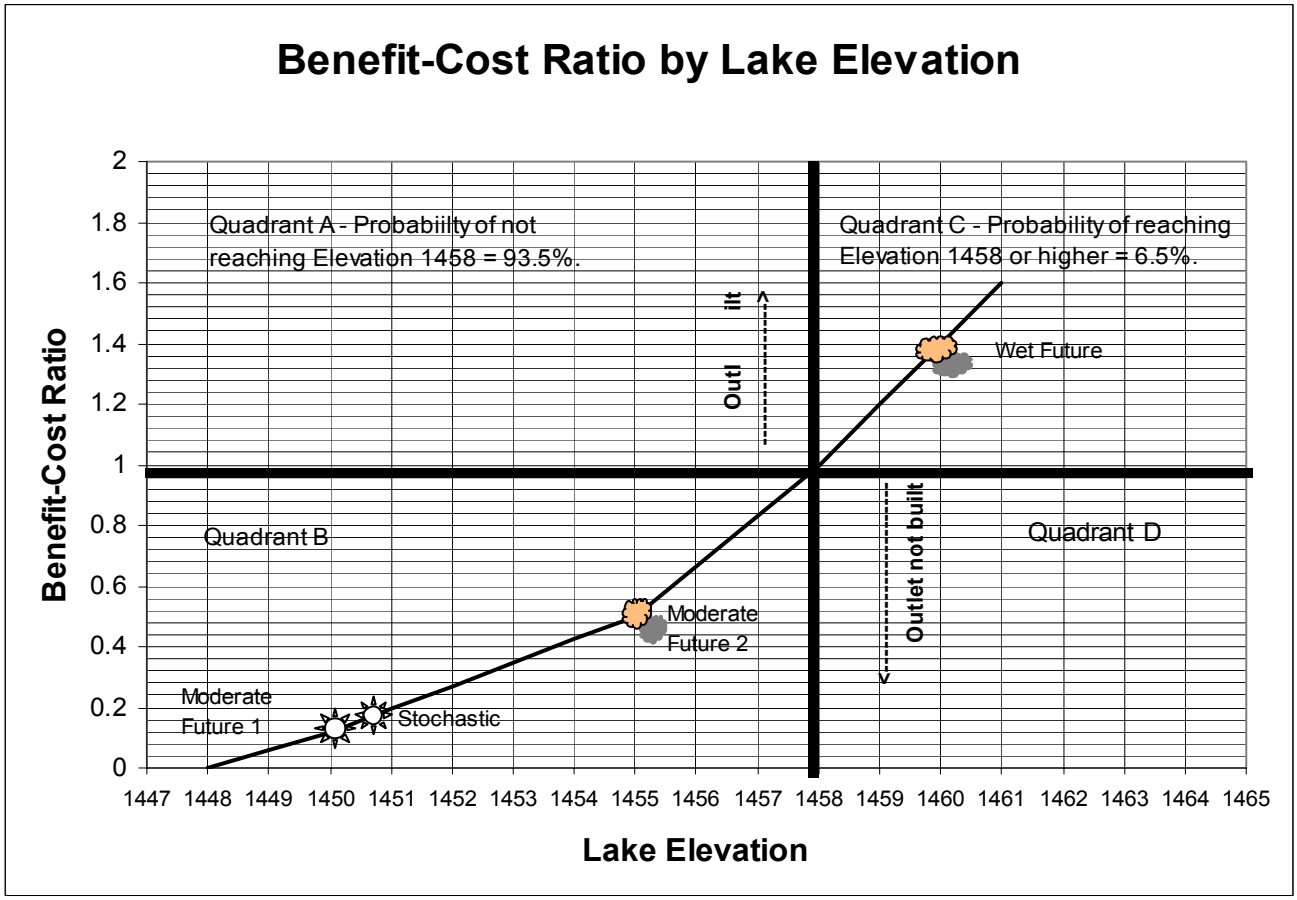

Figure 6-8: Benefit-Cost Ratio by Lake Elevation

Quadrants C and D represent those scenarios in which an outlet is feasible (lake elevation above 1458). There is a 6.5-percent chance of this occurrence in the next 15 years. The Wet Future scenario (lake elevation peaking at 1460) may be representative of these scenarios. If an outlet is built costing $186.5 million, damages in the amount of $577 million (present value basis) will still occur under the Wet Future scenario. If a decision is made not to build an outlet, the outlet costs of $186.5 million will be saved, but an additional $340 million in damages around the lake and downstream along the rivers, for a total of $917 million, will occur. The risk of not building an outlet means that there is a 6.5-percent chance that the lake will rise to a height that is sufficient to generate enough damages that could have justified construction of the outlet.

Table 6-12: Relative Risk of Building or Not Building an Outlet

(Costs expressed in $ million's)

Quadrant	**A**	**B**	**C**	**D**
Scenario [5]	Moderate Future 1 (1450) With Outlet [4]	Moderate Future 1 (1450) W/out Outlet	Wet Future With Outlet [4]	Wet Future Without Outlet
Max Lake Stage (feet above msl)	1447	1450	1457	1460
PV of Future Emergency Costs and Damages (Lake)	$54.2	$102.2	$381.1	$673.9
Downstream Damages and Costs (w/out erosion of natural outlet) [1]	$229.4	$227.4	$195.9	$242.7
Total Damages and Costs (w/out erosion of natural outlet) [1]	$283.6	$329.6	$577.0	$916.6
Damage and Cost Reduction Benefits due to Outlet	$46.0		$339.6	
Outlet First Costs	$186.5		$186.5	
PV of Net Benefits	-$140.5		$153.1	
Downstream Damages and Costs (with erosion of natural outlet) [2]	$229.4	$227.4	$195.9	$315.2
Total Damages and Costs (with erosion of natural outlet) [2]	$283.6	$329.6	$577.0	$989.1
Damage and Cost Reduction Benefits due to Outlet	$46.0		$412.1	
Outlet First Costs	$186.5		$186.5	
PV of Net Benefits	-$140.5		$225.6	

[1] Assumed to be the most likely future condition - expected overflow of 550 cfs
[2] Estimated to reach maximum discharge of 6,000 cfs; would only occur under wet future without an outlet; with-erosion scenario evaluated using only the West Bay outlet ---> results from this analysis used as a proxy for the equivalent value for the Pelican Lake outlet.
[3] Monetary values expressed in Present Value terms as million $'s
[4] With outlet means with Pelican Lake 300 cfs outlet
[5] Scenarios are representative of all traces that fall within the range indicated by the Quadrant

There has also been considerable discussion about the potential negative impacts of a natural overflow from Devils Lake into the Sheyenne River. Although the downstream effects of a natural overflow and a constructed outlet may be similar, there are some important differences. The effects of a natural overflow would be more short-term and drastic because of the magnitude of the event. The effects of an outlet are more long-term, subtle, and controllable, especially as related to some of the terrestrial and aquatic resources. If an outlet is constructed and the lake is still rising or even holding steady, the outlet would probably be operated. Downstream effects due to a natural overflow have a 9.4 percent chance of occurring in 50 years without an outlet. If an outlet is constructed and operated, downstream effects due to the operation of a constructed outlet would occur, even if the lake level does not go any higher.

The summary below identifies in relative terms the probability of occurrence of the effects to the resources. This is not based on a formal risk and uncertainty analysis. The terms give an indication of the likelihood of occurring under the with- and without-outlet **stochastic** future. This summary does not include the scenario future because the probability of it occurring is reflected in the stochastic future.

AREA OF CONCERN	WITH OUTLET	WITHOUT OUTLET
Groundwater	Likely	Unlikely
Aquatic	Likely	Unlikely
Terrestrial	Likely	Unlikely
Water quality	Highly likely	Unlikely
Erosion/Sedimentation	Highly likely	Likely
Cultural	Highly likely	Likely
Soil salinity	Likely	Unlikely
Water users	Highly likely	Unlikely
Sheyenne Delta vegetation	Likely	Unlikely
Biota transfer concerns	Highly likely	Unlikely
Damages occur around Devils Lake	Likely	Likely
Downstream effects occurring	Highly likely	Unlikely

SENSITIVITY

The following alternatives or possible futures were evaluated as a sensitivity to the stochastic or the wet future scenario. The sensitivity analysis assumed two moderate lake levels, erosion of the natural outlet, and a no-action future in which no further actions would be taken to reduce damages due to rising lake levels. The erosion of the natural outlet was based on an analysis of the materials present at the site and the potential for them to erode and not on the possibility that the area actually eroded in the past. All action assumes that the actions that have occurred in the past (road raises, levee construction, and relocations) would not continue into the future.

Social Resources

The social effects of the moderate lake levels would be similar to those described under the stochastic future but possibly to a smaller degree because the lake may not rise as high.

Natural Resources

Erosion of Natural Outlet

Because of the significant effects of erosion of the natural outlet, it was reasonable to assume that minimal erosion protection features would be instituted to prevent such erosion and were included as part of the without-project condition.

A sensitivity analysis was conducted assuming the natural outlet would erode and no actions would be taken to prevent it. The analysis is based on the materials present at the site and not on a determination if it actually eroded in the past. There is some debate over whether the outlet eroded in the past or accrued sediment. Materials at about 7 feet are over 7,000 years old. Devils Lake is estimated to have spilled to the Sheyenne River within the last 1,200 years; therefore, it did not erode at that time.

If the outlet were allowed to erode, the effects would be much more significant. It is estimated that the outlet could erode down to elevation 1450 with a maximum discharge of about 6,000 cfs and erosion of over 400,000 yd^3 of material. In the lake, the lands would be exposed quicker and recovery would be more rapid. There are approximately 114,685 acres between elevations 1450 and 1459 around Stump and Devils Lakes.

Downstream effects resulting from the erosion of the natural outlet would be significant. There would be increased sedimentation in the Sheyenne River and Lake Ashtabula. Erosion would also increase in the Sheyenne River. There would be substantial effects to the downstream aquatic resources on the Sheyenne and Red Rivers. Higher flows, changed water quality, sedimentation, erosion, increased groundwater levels, and overbank flooding would result in the loss of aquatic and riparian habitats. Aquatic biota and terrestrial wildlife populations in the riparian zone would be totally modified.

No mitigation would be implemented by the Corps for effects due to erosion of the natural outlet because it would be considered a natural condition.

Moderate Lake Levels of 1450 or 1455

The effects of the alternatives if more moderate climate scenarios (sensitivity analysis) were anticipated would be similar to those described under the stochastic future. The major difference for the outlet would be in the duration of the operation. Water quality effects would be somewhat greater due to the lower lake levels and resultant water quality conditions. Downstream effects on aquatic and terrestrial resources, erosion,

sedimentation, biota transfer, water users, land use, and soil salinity would be similar to the stochastic analysis, which was based on no overflow and a lower lake level.

Mitigation needs would be similar to those described for the stochastic analysis.

No Action

This sensitivity analysis assumes that, under the future without-project conditions, no actions would be taken in the basin to reduce or compensate for damages caused by rising lake levels. The effects that would occur include the effects of the alternatives. This applies to both the stochastic and scenario futures.

No mitigation would be required for this future without-project condition. Mitigation would be needed for the alternatives that may be implemented as described under the stochastic analysis.

State Outlet Alternative and 300-mg/l Sulfate Constraint Feature

This sensitivity analysis assumed the State outlet along Peterson Coulee would be constructed and operated as needed for the 50-year period of analysis with a more restrictive sulfate constraint of 300 mg/l.

The in-lake and downstream effects of reducing the sulfate constraint from 450 to 300 mg/l are not expected to be significant. They would be similar to the effects described for the Pelican Lake 450-mg/l sulfate outlet. Depending on the future climatic conditions, for example, under more moderate futures the water quality effects are less on the Sheyenne River with the 300-mg/l sulfate constraint. This could reduce the effects on aquatic resources if more moderate futures prevail.

It is assumed that the State's proposed outlet operation would be constrained to 300-mg/l sulfate water quality and 600-cfs channel capacity. For the Corps analysis it is assumed that the water quality effects are expected to be limited because of the sulfate constraint. The flow effects on natural resources resulting from the State outlet are expected to be less than those described for the Pelican Lake outlet because less water would be pumped overall and at any particular time. This is due to the water quality constraint and conditions in West Bay. The lower outlet flow would result in smaller changes in river stage, less groundwater effects, and less flow in the river than would result from the Pelican Lake outlet. Therefore, the State outlet should result in less effect to aquatic habitat and riparian vegetation. The impacts of the State outlet cannot be quantified and therefore the Corps is assuming that downstream impacts would be minimal with the State outlet and mitigation would be required if the Corps outlet is constructed.

Cultural Resources

Erosion of the natural outlet with its accompanying water discharge from Devils Lake and Stump Lakes would result in a burst of increased erosion of cultural resources sites

along Tolna Coulee and on the banks of the Sheyenne River. Overbank flooding and sedimentation of archeological sites along the Sheyenne River are also likely to occur. The effects of moderate lake levels on cultural resources would be similar to those under the Pelican Lake outlet alternative. If no action is taken, the effects on cultural resources would be similar to those identified under the future without alternative.

Other States, Nations, and Tribal Resources

Effects would be similar to impacts discussed under the scenario and stochastic analysis. Downstream interests may feel that allowing the outlet to erode is not reasonable based on all of the measures taken in the Devils Lake basin to reduce impacts. It may be felt that protection of the natural outlet from erosion is a reasonable and prudent action.

Moderate lake level sensitivity effects would be similar to those described for the stochastic analysis.

CUMULATIVE EFFECTS

Cumulative effects are the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative effects on natural resources of past actions in the Devils Lake and Red River basins have been significant. Social, cultural, natural, hydrologic, economic, and tribal resources have changed significantly as a result of past actions. Wetlands, woodlands, and grasslands have been lost, cultural sites have been destroyed, hydrologic characteristics have been altered, and the economy has been affected accordingly. Because the effects of past actions have been significant, the effects of future actions when added to these effects would also be significant, both adverse and beneficial.

For the purpose of this Integrated Planning Report/EIS, the incremental effects of continued infrastructure protection, upper basin storage, and an outlet are the features to be addressed for cumulative effects. The effects of some infrastructure and upper basin storage measures may be minor, but when added to past actions may be significant. The cumulative effects of infrastructure protection measures have, in the past, been considered to be additive and mitigated on a project-by-project basis. The effects of infrastructure protection on lake levels is limited. Some areas are removed from storage. Upper basin storage usually results in cumulative beneficial effects to natural resources and does not require mitigation. There may be negative effects to cultural resources. Upper basin storage also could be used to offset some of the lake level effects caused by infrastructure protection. The cumulative effects of infrastructure protection measures to woodland, wetland, and grassland resources would be about 500 acres. The cumulative effects of upper basin storage to woodland, wetland, and grassland resources would be about 12,000 acres. Assuming that 40,000 acres of depressions are used to store runoff,

there would be a net gain of about 37,000 acres of wetland and loss of about 8,500 acres of grassland and woodland if both the infrastructure protection and upper basin storage plans described in this report were implemented. It is assumed that the effects of infrastructure protection measures are mitigatable and would be addressed in separate NEPA documents by the implementing agencies.

The major incremental feature being addressed in this Integrated Planning Report/EIS is the outlet. The cumulative and incremental effects of an outlet would be significant, and the incremental effects and potential mitigation features have been identified in this Integrated Planning Report/EIS. Mitigation measures are included that would help the recovery of the Sheyenne River system after the outlet has ceased operation. It is assumed that over time the system would recover to pre-project conditions, but this may take decades and would result in losses during project operation.

Some reasonably foreseeable actions that are either being planned or considered by other agencies or groups include the following:

- Other flood reduction measures in Devils Lake basin and downstream such as levees, road raises, relocations, reservoirs, and diversions.
- Industrial expansion along the Red River.
- Residential developments.
- Road construction.
- Commercial development.
- Raise Baldhill Dam and Lake Ashtabula for flood control storage.
- Ecosystem restoration projects by various agencies.
- Water quality improvement measures by agencies.
- Wetland restoration efforts by the U.S. Fish and Wildlife Service, Natural Resources Conservation Service (NRCS), Tribal interests, and others.
- Actions taken to reduce nutrient loading.

These actions are identified as reasonably foreseeable only in that they have been identified as actions that other agencies are investigating for feasibility. It is not an indication of constructibility or whether the action would actually be implemented. They are identified only for purposes of cumulative effects.

For purposes of this analysis it is assumed that other flood control efforts would be implemented, there would be industrial, commercial, and residential expansion, wetland drainage would continue at its current rate, road construction would continue, and measures would be taken to increase wetland restoration and water quality improvements. These activities would have both beneficial and adverse effects to natural resources.

Most of these efforts would cumulatively add to the effects caused by the Devils Lake flood damage reduction project. An outlet would be counter to the restoration efforts and would add to the significance of the adverse effects.

Most of these activities would make the effects caused by the outlet more significant by further degrading the base condition such as degraded water quality and a reduced

quantity and quality of natural resources. An outlet could be counter to some efforts such as activities to restore wetlands and initiatives to decrease nutrient loading on the Sheyenne and Red Rivers.

The incremental effects of the outlet when added to these other reasonably foreseeable actions would be significant also. Depending on which projects are in place first, there may be an effect on how subsequent projects would be operated. Increases in TDS concentrations on the Red River may affect how and to what degree industrial users may discharge to the Red River. Operation of an outlet may also affect operational constraints of any new impoundments in the Red River basin. Any future actions that add additional flow to the Sheyenne River may have an affect on its ability to recover after an outlet has ceased operation. Implementing agencies and permit applicants would be responsible for considering the effects of any previously constructed projects in its determination of impacts.

The effects of the outlet are determined to be additive, indirect, and time lag. It is the determination of the Corps that the incremental effects when considered by themselves or in conjunction with other reasonably foreseeable actions are significant but do not result in any additional impacts above those described in this Integrated Planning Report/EIS. The proposed mitigation feature and monitoring protocol are reasonable measures that should be included to minimize the effects of the construction and operation of an outlet and help the recovery of the system.